TABLE OF CONTENTS

		Page
1.	INTRODUCTION	
1-1.	Function	4
1-2.	Composition	4
1-3.	Additional Equipment Required	5
2.	DETAILED DESCRIPTION OF PRINCIPAL COMPONENTS	
2-1.	Type MN-26A Radio Compass	6
2-2.	Type MN-28A and Type MN-28C Remote Control Units	8
2-3.	Type MN-20A or Type MN-24A Rotatable Loop	9
2-4.	Type MN-22A Azimuth Control	9
2-5.	Type MN-52A Azimuth Control	9
2-6.	Type IN-4A Left-Right Indicator	9
2-7.	Warning Lights	10
2-8.	Junction Box	10
2-9.	Electrical Radio Compass Theory	10
3.	INSTALLATION	
3-1.	Preliminary Inspection	11
3-2.	Bonding and Shielding	11
3-3.	Location and Mounting of Radio Compass Equipment	11
3-4.	Cable Connections	12
3-5.	Antenna Types and Connections	12
4.	PREPARATION FOR USE	
4-1.	Tests Before Installation in Aircraft	13
4-2.	Tests After Installation	13
4-3.	Loop Gain Adjustment	14
4-4.	Threshold Sensitivity Adjustment	14
4-5.	Quadrantal or Aircraft Error Calibration	14
4-6.	Performance Tests	18
5.	OPERATION	
5-1.	General	19
5-2.	Communications Reception	19
5-3.	Homing	19
5-4.	Direction Finding	20
6.	MAINTENANCE	
6-1.	Lubrication	21
6-2.	Routine Inspections	21
6-3.	Servicing Data	22
6-4.	Radio Compass Unit Alignment	26
6-5.	Overall Performance Characteristics	27
7.	PARTS LIST BY SYMBOL DESIGNATION FOR MODEL MN-26A and MODEL MN-26C RADIO COMPASS EQUIPMENT	
7-1.	Type MN-26A Radio Compass	30
7-2.	Type MN-26C Radio Compass	33
7-3.	Type MN-28A and MN-28C Remote Control	33
7-4.	Type MN-20A and MN-24A Rotatable Loops	34
7-5.	Type IN-4A Left-Right Indicator	34
7-6.	Type MN-22A Azimuth Control	34

LIST OF ILLUSTRATIONS

Page

Fig. 1—Composite View, MN-26A or MN-26C Equipment 35

Fig. 2—Top View, MN-26A Radio Compass 37

Fig. 3—Bottom View, MN-26A Radio Compass..... 39

Fig. 4—Bottom View, MN-26A Radio Compass..... 41

Fig. 5—MN-28 Remote Control Units 43

Fig. 6—Detailed View, MN-22A Azimuth Control 45

Fig. 7—Detailed View, MN-20A Rotatable Loop..... 45

Fig. 8—Detailed View, IN-4A Left-Right Indicator 45

Fig. 9—Schematic Diagram, Radio Compass Equipment 47

Fig. 10—Outline Dimensions, MN-26 Radio Compass Units 49

Fig. 11—Outline Dimensions, MN-28 Remote Control Units 51

Fig. 12—Outline Dimensions, MN-20A Rotatable Loop 53

Fig. 13—Outline Dimensions, Left-Right and Marker Indicators 55

Fig. 14—Ship Mounting Cutout, MN-20, MN-24 Loops 57

Fig. 15—Position of Tach Shaft, MN-20, MN-24 Loops 59

Fig. 16—Outline Dimensions, MN-22A Azimuth Control Unit 61

Fig. 17—Procedure for Obtaining Quadrantal Error Data in Flight 63

Fig. 18—Typical Quadrantal Error Data Sheet..... 65

Fig. 19—Quadrantal Error Data Sheet 67

Fig. 20—Typical Quadrantal Error Calibration Curve 69

Fig. 21—Quadrantal Error Calibration Chart 71

Fig. 22—Model MN-26M Aircraft Radio Compass Equipment 73

FREQUENCY RANGE
MODEL MN-26A & MODEL MN-26C

BAND I	150 — 325 KCS
BAND II	325 — 695 KCS
BAND III	695 —1500 KCS

POWER REQUIREMENTS

	Volts	Amps.
MODEL MN-26A	14	5.5
MODEL MN-26C	28	3.0

The band switch motor draws approximately 2 amperes additional current in the 14-volt equipment and 1 ampere additional current in the 28-volt equipment when bands are being shifted.

INSTRUCTION BOOK

for

MODEL MN-26A & MODEL MN-26C AIRCRAFT RADIO COMPASS EQUIPMENT

1. INTRODUCTION

1-1. FUNCTION

The Model MN-26 Radio Compass Equipment, consisting of a radio compass receiver, remote control unit, azimuth control, loop and sense antennas, left-right and warning light indicators, interconnecting cables, and the necessary power source, comprises an aircraft navigational equipment which provides:

Visual unidirectional left-right indications of the arrival of radio frequency energy with respect to the plane of the loop; also, simultaneous aural reception of modulated or unmodulated radio frequency energy.

Aural reception of modulated or unmodulated radio frequency energy using a nondirectional antenna.

Aural reception of modulated or unmodulated radio frequency energy using a loop antenna, especially desirable during periods of rain and snow static.

Aural null directional indications of the arrival of modulated or unmodulated radio frequency energy with respect to the plane of the loop antenna.

Visual warning indication of off-zero loop settings.

The radio compass receiver is a remotely controlled, 12-tube superheterodyne, with an intermediate frequency of 112.5 kilocycles. The frequency range of the equipment is from 150 to 1500 Kcs, which is covered in three bands calibrated in kilocycles as follows: Band I, 150 to 325 Kcs; Band II, 325 to 695 Kcs; Band III, 695 to 1500 Kcs.

The equipment is tuned manually from the remote control unit which may be mounted within easy reach of the operator. The bands are switched electrically by means of a selector switch on the control unit.

The Model MN-26A Equipment is used for operation from a 14-volt DC primary power source, and the Model MN-26C Equipment, which is similar except for the low voltage power source and associated circuits, is used for 28-volt DC installations.

1-2. COMPOSITION

Three arrangements of the Model MN-26A Aircraft Radio Compass Equipment are possible, depending upon the requirements of the user. Certain components are used in all of the arrangements, while others are used in only one arrangement. In Section 1-2-1 the components required in each case are listed briefly, while in Section 1-2-2 each component is described more fully.

1-2-1. COMPONENTS REQUIRED FOR EACH ARRANGEMENT

Item	*Quantity*	*Description*	*Wt. - Lbs.*
		SYSTEM 1	
A	1	Type MN-26A or MN-26C Radio Compass	37.37
B	1	Type MN-28A or MN-28C Remote Control	2.75
C	1	Type MN-52A Azimuth Control	.88
D	1	Type MN-20A Rotatable Loop; or	5.00
	1	Type MN-24A Rotatable Loop	6.80
E	1 or 2	Type IN-4A Left-Right Indicators	ea. 1.75
F	1	A30065 Loop Off-Zero Warning Light Assembly	.063
G	2	AA15410-1 Tuning Shafts	.265
H	1	AC55966-1 Loop Transmission Cable Assembly	.15
I	1	AL71095-2 Junction Box	2.44
J	1	*Power Cable	. .
K	1	*DC Input Cable	. .
L	1	*Remote Control Cable	. .
M	1	*Azimuth Control Cable	. .
N	1 or 2	*Left-Right Indicator Cable	. .
O	1	*Sidetone Cable	. .
P	1	*Warning Light Wire	. .

Item	*Quantity*	*Description*	*Wt. - Lbs.*
		SYSTEM 2	
		All items the same as in System 1, except substitutions as follows:	
C	1	†Type MN-22A Azimuth Control, with	1.81
	1	†Type MR-21A Crank	.12
F		Not Used	
M	1	*†Azimuth Control Unit Dial Lamp Cable	. .
P		Not Used	
		SYSTEM 3	
		All items the same as in System 1, except substitutions as follows:	
C	1	†Type MN-22A Azimuth Control, with	1.81
	1	†Type MR-15A Crank Drive	.375
F		Not Used	
M	1	*†Azimuth Control Unit Dial Lamp Cable	. .
P		Not Used	

* Interconnecting cables supplied to customer's specifications.

† Instructions for the installation and operation of these items in conjunction with this or other direction finding equipment are contained in a separate instruction pamphlet supplied with these units.

1-2-2. Detailed Description of Components

Item *Description*

A Type MN-26A or MN-26C Radio Compass complete with mounting base; tubes as follows: 1-6L7, 2-6N7, 1-6B8, 2-6J5, 5-6K7, 1-6F6, and cable connectors as follows: 1-B7380-2 antenna plug. 1-A30095 cord plug.

B Type MN-28A or MN-28C Remote Control complete with mounting base, fuse, and 1-A30090 cord plug. (MN-28A for 600 ohms output; MN-28C for 4000 ohms output.)

C Type MN-52A Azimuth Control complete with 1-A30088 cord plug; or Type MN-22A Azimuth Indicator complete with Type MR-21A Crank and 1-AA25718-1 cord plug; or Type MN-22A Azimuth Indicator complete with Type MR-15A, 2 to 1, Crank Drive and 1-AA25718-1 cord plug.

D †Type MN-20A Rotatable Loop Unit, 9″ diameter, complete with either 1-AA14695-1 90° or 1-AA14660-1 straight tuning shaft fitting; or Type MN-24A Rotatable Loop Unit, 18″ diameter, complete with either 1-AA14695-1 90° or 1-AA14660-1 straight tuning shaft fitting.

The bases of both loops are the same, the loop diameters *only* are different. Electrical characteristics are identical.

E Type IN-4A Left-Right indicator complete with A30088 cord plug, 1-AA18824-1 meter field load assembly.

F A30065 Loop Off-Zero Warning Light assembly with A9320-2 12/16-volt bulb, 1-A30181 warning light dropping resistor (R41).

Item *Description*

G AA15410-1 Flexible tuning shaft, length as specified.

H AC55966-1 Loop Transmission Cable; shielded 3-conductor, length as specified (168″ maximum, standard lengths 42″ and 168″). Completed assembly with one 90° and one straight cord plug.

I AL71095-2 Junction Box (MS-14B) Location of cable entering holes as specified; larger sizes of junction boxes may be obtained when interconnections with other equipment are desired.

† Type MN-20A and MN-24A Rotatable Loops equipped with 90° mechanical control fittings. For 180° fittings, order Type MN-20C and MN-24B, respectively.

1-3. ADDITIONAL EQUIPMENT REQUIRED

The following additional items must be provided by the customer in order to operate this equipment:

Item	*Quantity*	*Description*
A.	1	14- or 28-volt DC primary power source as required for the equipment.
B.	1	Suitable antenna system.
C.	1 or 2	Pair of MR-8E 600-ohm headphones. High impedance, MR-48A, 4000-ohm headphones may be used if the equipment has been ordered with high impedance output circuits.

2. DETAILED DESCRIPTION OF PRINCIPAL COMPONENTS

2-1. TYPE MN-26A RADIO COMPASS

2-1-1. MECHANICAL

Each Type MN-26A Radio Compass Unit includes a cabinet, chassis, and mounting base. The radio compass unit contains the compass circuit elements, the superheterodyne receiver circuit elements, and the high voltage power supply. This unit also includes one set of vacuum tubes, one 6/32 socket type setscrew wrench, and 5 grid shield caps.

The radio compass receiver chassis is housed in a dust and spray proof cabinet formed of aluminum sheet and finished in grey wrinkle enamel. Slides in the base of the cabinet permit easy withdrawal of the chassis, which is held securely in place by a captive through-bolt running from the front panel of the chassis to a riveted nut in the back of the cabinet.

The mounting base consists of an aluminum base plate, with rubber shock absorbers mounted in the four corners. For outline dimensional drawing and drilling diagram see Figure 10.

The chassis of the radio compass receiver is formed of welded aluminum and is so constructed that when servicing the unit it may be placed on any of five sides without damage. A panel containing all of the cable terminations is attached to the front end of the chassis. All circuits are so shielded that after the equipment is aligned, the chassis may be placed in its cabinet without changing the alignments. The setscrew wrench is clipped to the middle chassis cross member. The sub-assemblies and other components on and under the chassis deck are arranged to provide the optimum in accessibility for maintenance. Refer to Figures 2, 3, and 4.

2-1-2. ELECTRICAL

2-1-2-1. General

The Type MN-26A Radio Compass Unit comprises a compass circuit and a receiver circuit. The receiver may be operated with a loop antenna or nondirectional antenna as desired. The frequency range (150-1500 Kcs) is covered in three bands (150-325, 325-695, and 695-1500 Kcs). Band selection is accomplished by a motor-driven band-change switch, the switch sections inserting into each circuit the coils for the desired band and shorting out all unused coils, thereby preventing any resonant absorption circuits. The schematic diagram, Figure 9, shows the equipment being operated as a compass on Band I. The following circuit description traces the circuit for Band I only. A corresponding description would apply to Bands II and III, should the band switch be set to either of these positions. The important elements of the circuit are illustrated in photographs, Figures 2, 3, and 4.

2-1-2-2. Compass Circuits

The theory of compass operation is explained in Section 2-8. The loop consists of a center-tapped coil. The outer ends of the winding and center tap are connected to a receptacle J8 at the base of the loop through which the loop output voltage is fed into the loop transmission cable to be conducted to the primary of the loop input transformer T1. Refer to Figure 9. The secondary of T1, tuned by the first section of the ganged tuning capacitor C2-1 is connected to the grid of the loop amplifier tube. The output of this tube is fed to the phaser, which consists of a shunt circuit L1 and C38 resonated to a frequency somewhat lower than that of the IF stages. This presents a capacitive reactance to signals of any frequency to which the compass may be tuned (150-1500 Kcs). Since the plate resistance of the loop amplifier tube is very high compared to the reactance of its load L1, C38, the voltage across the capacitive reactance C38 in the plate circuit is effectively changed in phase 90 degrees from the voltage on the grid of the tube.

RF voltage across C38 is fed through capacitors C19-1 and C19-2 to the grids of the modulator tube V3. The grids of the modulator tube are biased to cut-off, and are connected in push-pull through capacitors C3-18 and C3-19 and resistors R12-6 and R12-7 to the plates of the audio oscillator tube V2. These plates are connected in push-pull to the left-right indicator field which is resonated at 48 cycles by the internal capacitor. Grid excitation for the audio oscillator is supplied through capacitors C3-13 and C3-14 which are cross-connected to the opposite plates. The audio frequency oscillator output voltage renders the two triode sections of the modulator tube conductive in turn, by alternately overcoming the cut-off bias on each grid. The plates of this modulator tube are connected in push-pull to one primary winding of the antenna input transformer T4. The nondirectional vertical antenna voltage is applied to the second primary of T4. Both primaries are inductively coupled to the same secondary winding which is tuned by C2-2, the second section of the ganged tuning capacitor. This tuned secondary winding is connected to the grid of the first RF tube V4, applying voltages from the loop and nondirectional antenna to the grid of this tube. However, the voltage of the loop is alternately changed in phase 180 degrees at twice the audio oscillator frequency by action of the push-pull modulator tube V3 and, therefore, is alternately added to and subtracted from the antenna voltage at the grid of the first RF tube. Thus, a signal is applied to the grid of the first RF amplifier tube which is modulated at the audio oscillator frequency. The level of this signal depends on the effective height of the nondirectional antenna. The loop gain control R1 is provided to allow adjustment of the modulator tube gain so that the loop voltage at the grid of the first RF tube is at approximately the same level as the voltage obtained from the nondirectional antenna. The combined loop and antenna voltage is amplified and detected by the receiver circuits and the audio

frequency component, containing the audio signal and meter signal frequencies, is fed to the grid of the audio output tube V11 through capacitor C16 and to the grid of the compass output tube V12 through capacitor C7. The level of the audio voltage applied to the compass output tube grid is determined by the compass sensitivity control R3 which is mounted on the remote control unit. The plate of the compass output tube is connected to the primary winding of the output transformer T16. The primary of this transformer is resonated to 48 cycles by capacitor C5-2 and so acts as a filter to pass only 48 cycles. The secondary of the transformer is connected to the moving coil of the left-right indicator and provides the power required to actuate the indicator pointer. When only one indicator is used, it is necessary to connect the meter field load assembly into the circuit as shown in Figure 9.

2-1-2-3. Receiver Circuit

The receiver circuit is of the superheterodyne type and consists of three stages of tuned radio frequency amplification (including first detector), a radio frequency oscillator, an intermediate frequency amplifier, a second detector and audio amplifier, an AVC circuit, an audio output amplifier, a compass output tube, and a CW beat frequency oscillator. A clearer idea of the following circuit description can be obtained by referring to Figure 9. While the description traces only the circuit for Band I, it is applicable to other bands by substituting the appropriate coils for those bands.

The nondirectional vertical antenna connects to a relay RE1, which performs two functions: When on COMP. or REC. ANT., the nondirectional antenna connects directly through the relay contacts to the primary of T4, the antenna input transformer; when on REC. LOOP, the relay connections are arranged to ground the nondirectional antenna and to substitute a capacitor C21-1 across the antenna primary winding of T4, the antenna input transformer. Resistor R18 connects directly to the antenna and permits electrostatic charges to leak off to ground when the antenna is ungrounded. The capacitor C15 prevents damage to the antenna transformer when a DC voltage is applied to the antenna. The primaries of T4 are inductively coupled to the secondary which is tuned by the second section of the ganged tuning capacitor C2-2. The grid of the 1st RF tube connects to the secondary of the transformer. A small neon tube between the grid and ground protects tube and circuit elements against high antenna voltages which may result from operation of the airplane's transmitter or from high electro-static charges on the antenna.

A coil L2 in the cathode lead is resonated at 110.5 Kcs by capacitor C14-1 and acts as a trap circuit to attenuate unwanted signals near the intermediate frequency.

The plate of the first RF tube couples through transformer T7-1 to the grid of the second RF tube, the secondary of transformer T7-1 being tuned by the third section of the ganged tuning capacitor C2-3. An IF trap circuit L3, C14-2, in the cathode lead of the second RF tube, is tuned to 114.5 Kcs. The plate of this tube connects to the primary of transformer T7-2 the secondary of which is tuned by the fourth section of the ganged tuning capacitor C2-4 and connects to the control grid of V6, the third RF or first detector tube.

The injector grid of the first detector is excited by the output of triode oscillator tube V7 which is tuned 112.5 Kcs above the desired signal by the fifth section of the ganged tuning capacitor C2-5. The plate circuit of this detector tube is tuned to 112.5 Kcs, and couples inductively to the control grid of IF tube V8.

The plate circuit of IF amplifier tube V8 is tuned to 112.5 Kcs and is coupled inductively to a second tuned circuit, which connects to one diode rectifier plate of the second detector tube.

Output from the CW beat frequency oscillator V9 is coupled to the above mentioned diode plate. Operation of the tube V9 is controlled by S10, a toggle switch (C.W. ON-OFF) located on the remote control unit.

The grid of the second detector tube V10 receives the audio component of the rectified radio frequency signal at the junction of the diode load resistors R14-5 and R28.

The second diode plate is fed from the plate circuit of the IF tube through capacitor C21-4, and supplies AVC bias for tubes V4, V5, V6, and V8. The greater the amplitude of the received signal, the greater will be the voltage built up across the AVC load resistor R22-4 by the rectified carrier. Since the control grids of the preceding tubes are connected to the negative end of the resistor, negative bias on them will be increased by a strong carrier, and because of their variable amplification characteristics, they will operate at reduced gain on such signals. Conversely, on weak signals the bias introduced by the AVC will be smaller and the tubes will operate at higher gain. This action tends, therefore, to maintain incoming signals at a constant level. The AVC circuit operates only when the master switch is set at COMP.

The plate of the second detector tube is resistance-capacity coupled to the grid of the audio output tube V11. The plate of this output tube is connected to the primary of output transformer T15. The secondary of this transformer is tapped for connection to 600-ohm or 4000-ohm output circuits. The output of transformer T15 is connected to the headset jacks J1 and J2. See Figure 9 for complete circuit.

2-1-2-4. Band Change Circuit

Band changing is effected by switching the tuned circuits in the loop, first RF, second RF, first detector, and RF oscillator stages by means of motor-driven switches. The motor armature drives a worm gear which is ganged on a common shaft with the crank arm and locking cam, the control cam, switches S5B, S5C, and the RF band change switches. When the remote control unit band selector switch S9 is operated to select

a different band, band switch motor MO is energized by completing the circuit to ground through the contacts of S9 and S5B. The motor drives the crank arm through one or two complete revolutions which steps the Geneva disc until the motor is deenergized by the opening of S5B, which is on the same shaft as the Geneva disc and the switches that select the tuned circuits. Exact control of the positioning is obtained by the cam-operated switch S6. When the motor is at rest, the arm of switch S6 is on step 2 of the control cam, and all contacts are open. When the motor starts, the arm is first raised by step 3 of the cam, closing the upper contacts, which at this time perform no function since the corresponding contact of S9 will be open. As the motor continues operating, the arm of S6 will drop to step 1 of the cam, opening the upper contacts and closing the lower ones. The closing of the lower contacts provides an additional path to ground to keep the motor energized after the opening of S5B by the movement of the Geneva disc, and also grounds the audio output of the radio compass unit to prevent clicks while changing bands. When the crank arm has been driven past the Geneva disc, engaging the locking cam with the arc of the disc, the control cam raises the arm of S6 to step 2, opening all contacts, and the motor coasts to a stop. If it should coast past step 2, the upper contacts of S6 will be closed by the control cam and will now energize the reverse field of the motor through the contacts of S5C and S9 and the motor will reverse to the proper position until all contacts of S6 open.

2-1-2-5. Sidetone Circuits

A portion of the audio voltage from a transmitter may be fed to the audio input circuit of the MN-26 receiver for purposes of monitoring transmissions. Relay RE2 is connected into the grid circuit of the audio amplifier tube V11 to allow input from either the receiver circuits or the transmitter sidetone circuits. The unoperated or normal position of the relay provides continuity of the output circuits. The operated position of the relay grounds the receiver AVC buss and connects the externally applied (approximately 1.5 volts) voltage to audio amplifier tube V11. Voltage for operation of the relay solenoid is obtained from the radio compass primary voltage and is controlled by connecting the transmitter push-to-talk switch to the negative and positive sidetone leads. All connections to the sidetone relay circuit are to be made in the junction box as shown on Figure 9.

2-1-3. MN-26A AND MN-26C EQUIPMENT DIFFERENCES

The Type MN-26C Radio Compass (28-volt) is essentially the same as the MN-26A (14-volt) unit, the differences being necessitated by the change of primary voltage. The changes are as follows: (See MN-26C parts list and Figure 9 for details and part numbers.)

A 24/28-volt instead of 12/14-volt band switch motor is used.

A 24/28-volt instead of 12/14-volt dynamotor is used.

Resistor R36 has the jumper removed (see Figure 9).

Resistor R35-1 has the jumper removed.

Resistor R37-2 has the jumper removed.

The filament terminals numbered 2 and 3 must be connected. Terminals 1 and 4 will be disconnected.

Resistor R35-3, mounted in the remote control unit, must have its jumper removed.

Resistor R41, in the junction box, must have its jumper or jumpers removed.

2-2. TYPE MN-28A AND TYPE MN-28C REMOTE CONTROL UNITS

2-2-1. GENERAL

The remote control unit includes a lamp LM-1, 1 No. 6/32 socket stype setscrew wrench, and 1 base which may be drilled for mounting screws, as shown in Figure 11. The remote control unit contains all controls for operation of the radio compass unit. The differences between the two remote control units are discussed in paragraph 6, Section 2-2-2.

2-2-2. CONTROLS (SEE FIGURE 5)

The following controls appear on the remote control unit:

TUNING CRANK: The TUNING crank operates the remote control dial and is connected through a train of gears and the flexible tuning shaft to the ganged tuning capacitor in the radio compass unit. The gear ratio between the crank and the ganged capacitor is 120 to 1.

DIAL: A radial disc type dial is used which is calibrated every 5 Kcs from 150 to 325 Kcs and every 10 Kcs in the two bands from 325 to 1500 Kcs. The dial is illuminated by a lamp LM-1.

BAND SWITCH: The frequency band selector switch S9 located below the dial, energizes the band switching motor and thus is capable of selecting any of the three bands, 150-325, 325-695, and 695-1500 Kcs. A mask, attached to the switch shaft, permits viewing only that part of the tuning dial associated with the band selected. The band range in use is marked on the mask.

OFF-COMP.-REC.ANT.-REC.LOOP: A four-position switch S8 selects the desired operating function. In the OFF position, no current is drawn from the low voltage power supply. In the COMP. position, the circuit elements are arranged to provide compass operation. In the REC.ANT. position, the equipment functions as a communication receiver connected to the nondirective vertical antenna. In the REC.LOOP position, the equipment functions as a communication receiver connected to the directional loop antenna.

LIGHT: The control knob designated LIGHT regulates the brilliancy of the lamp LM-1 that illuminates the calibrated dial.

AUDIO: The control knob designated AUDIO regulates the level of the audio signal in the

headsets. This control is a dual potentiometer connected in the headset and RF amplifier cathode circuits. When functioning as a compass, the equipment is operating on automatic volume control (AVC) and this knob, by varying the potentiometer section in the headset circuit R4A, determines the audio level in the headphones. When the equipment is functioning as a receiver, on either REC.ANT. or REC.LOOP positions, this control knob varies the gain of the radio frequency amplifiers, permitting radio range reception. The MN-28A remote control used with 600-ohm low impedance output systems is the same as the MN-28C remote control used with 4000-ohm high impedance systems except for the audio control potentiometer R4. See Section 7-3, parts list.

COMPASS: The control knob designated COMPASS operates a potentiometer R3 to regulate the extent of pointer deflection of the left-right indicator.

TEL JACKS: The two jacks J1 and J2 marked TEL receive standard two contact (barrel and tip) headphone plugs.

THRESHOLD SENSITIVITY: A control R2 is mounted inside the remote control unit case. This control is adjusted at the time of installation (COMPass operation only) to limit the gain of the radio frequency amplifiers to such an extent that erratic fluctuation of the left-right indicator due to noise is eliminated. Instructions for setting this control are given in Section 4-4.

2-3. TYPE MN-20A OR TYPE MN-24A ROTATABLE LOOP

The loop consists of a coil with center tap, enclosed in an electrostatic shield. At the top of the shield is a gap which is insulated, and waterproofed. The loop is permanently fastened into the mounting base. All connections from the loop coil are made through slip rings to brushes which are connected to the loop transmission cable receptacle. Rotation of the loop is accomplished by means of the associated azimuth control, flexible tuning shaft, and fittings which drive the loop gears that are located in the mounting base.

2-4. TYPE MN-22A AZIMUTH CONTROL

Essentially the Type MN-22A Azimuth Control consists of a double-ended tach-shaft drive to which is connected, through an appropriate gear and cam drive, a pointer that moves in the horizontal plane against the indicator dials. It is designed for use with standard aircraft tachometer shafts.

Connected to the internal gearing is a circular cam scribed with nine circles and twenty-four radial lines corresponding to degrees correction and degrees azimuth rotation respectively. The cam may be cut to any required shape to meet the particular installation and can accommodate a maximum error of plus or minus 20 degrees. As supplied the cam introduces no correction and can, if no error correction is required, be used without further adjustment.

Two instrument lamps provide ample illumination.

The Type MN-22A Azimuth Control provides means for obtaining loop rotation and bearings (indications of loop settings corrected for quadrantal error) as follows:

A. Bearings relative to ships heading are read on the outer fixed dial.

B. Magnetic bearings are read under the pointer on the inner movable dial, after the number on this dial, which corresponds to the airplane's magnetic course, has been set at the zero mark on the fixed dials.

C. True bearings are read under the pointer on the movable dial after the number on this dial, which corresponds to the airplane's magnetic course, has been set opposite the east or west compass variation shown on the inner fixed dial.

D. Reciprocal bearings can be read at the opposite end of the pointer.

2-5. TYPE MN-52A AZIMUTH CONTROL

The Type MN-52A Azimuth Control is designed for mounting on the instrument panel or alongside of the pilot, Figures 6 and 13. It has a dial calibrated to give direction readings to 2.5 degrees, readings to one degree being readily obtained by interpolation. The dial is illuminated by a pilot light LM-2 which is turned on or off by the LIGHT toggle switch S11.

A cam on the dial pointer shaft maintains contact through the cam operated switch S12 at all positions of the dial pointer except zero. This switch when connected to an appropriate warning light indicates off-zero loop settings.

2-6. TYPE IN-4A LEFT-RIGHT INDICATOR

The indicator is designed for instrument panel mounting, and must be *individually shock mounted if the instrument panel is not provided with shock absorbers.* The indicator dial is marked with a small conventionalized figure of an airplane to indicate on course flight. The dial markings and pointer are coated with luminous paint for visibility during night flying. The movement is of the iron-core dynamometer type. The field coil is center-tapped and serves as the plate inductance for the audio oscillator, being resonated by a capacitor which is mounted inside the case. This capacitor may be removed by taking off the meter case, unfastening the two mounting screws which hold it in place, and unsoldering the leads. Terminals 2 and 4 of the receptacle connect to the moving coil, and terminals 1, 3, and 5 to the field winding.

When one meter is used with the equipment, it is necessary to connect the field resonating meter load assembly supplied with the meter into the junction box as shown in the schematic diagram, Figure 9.

2-7. WARNING LIGHT

The warning light or lights provide visual warning indication of off-zero loop settings when a Type MN-52A Azimuth Control is used. The light is turned on or off by the cam operated switch located in the Type MN-52A Azimuth Control Unit. A voltage dropping resistor R41 is supplied complete with mounting hardware for installation in the junction box. This resistor should be wired as shown on Figure 9. It will be necessary to use this resistor on 28-volt installations.

2-8. JUNCTION BOX

All interconnections between the various units are made in the junction box. The junction box is provided with 8/32 screw size terminals upon which connections are made. See Figure 9 for interconnections. When one left-right indicator is used, it is necessary to connect the field resonating meter load assembly in the junction box as shown in Figure 9. All mounting hardware is supplied with the assembly; it is necessary that the mounting holes be drilled as required for the installation. Number 18 ga. wire will be sufficiently heavy for all leads except those marked, which should be 12 ga. The leads from plug P3 terminal 9 to plug P4 terminal 22 should have the best of insulation in order to minimize AVC leakage.

When no tuning meter is used with the equipment, the wire in the radio compass unit cable connecting to terminal 18 of plug P4 must be grounded. When a tuning meter is used, this wire must be connected to the positive meter lead. The negative meter lead must be returned to the junction box ground buss. A suitable meter for use in this circuit would be an aircraft type 0-5 milliampere meter with a suppressed zero movement arranged so that the pointer shall leave the right-hand (viewed from the front) zero stop with approximately 2 milliamperes and shall read full scale at the left stop with 5 milliamperes.

2-9. ELECTRICAL RADIO COMPASS THEORY

The radio compass equipment consists of a loop antenna, a loop input circuit and amplifier, a 90-degree phase shifter, a balanced modulator, an audio oscillator, a nondirectional antenna, a sensitive and selective receiver, a compass output circuit, a left-right indicator, and a telephone output circuit. The vertical antenna is nondirectional, that is, equally sensitive to radio signals from any direction. The voltage induced in a vertical antenna is in phase with the flux of the radio wave.

The loop antenna is directional in that the voltage induced in the loop is maximum when the plane of the loop is turned toward the transmitter and is zero when the plane of the loop is perpendicular to the direction of travel of the radio wave from the transmitter. The resultant of the voltage induced in the loop is 90 degrees out of phase with the voltage induced in the vertical antenna and changes abruptly 180 degrees as the loop is rotated through the position of zero pick-up.

The voltage from the loop is amplified and shifted through 90 degrees so that it is either in phase with or in phase opposition to the voltage induced in the vertical antenna, depending upon which edge of the loop is turned toward the transmitter.

The voltage from the loop amplifier is then impressed upon the grids of the modulator tube which are driven in phase opposition by the audio oscillator so that only one of the triode sections passes the loop signal at a time. Since the plates of the modulator tube are push-pull connected to the receiver circuits, they alternately add to and subtract from the voltage contributed by the vertical antenna. The addition of the loop signal to the signal from the nondirectional vertical antenna reverses in phase as the loop is rotated through a null position. The audio oscillator also provides alternating current for the field of a dynamometer type left-right indicator.

The receiver circuit amplifies the combined signal which is modulated at the audio oscillator frequency proportionally to the voltage contributed by the loop. Moreover, the phase of the modulation reverses as the loop is rotated through a null. The modulated signal is then detected, amplified, and impressed upon the moving coil of the left-right indicator.

The compass circuits are arranged so that, if the radio signal is coming from the ship's left, the modulation is such that the indicator pointer turns to the left, and if the radio signal is from the ship's right, the pointer of the indicator turns to the right. When the signal is on the axis of the loop, the loop voltage is zero, there is no modulation of the carrier at the frequency of the audio oscillator, and the indicator pointer remains at center.

The voltage induced in the loop by a radio wave from the transmitter is coupled to the loop amplifier tube V1, through transformer T1. The parallel combination of L1 and C38 in the plate circuit of V1 has a capacitive reactance at the signal frequency so that the phase of the signal voltage is shifted 90 degrees when impressed upon the grids of the modulator tube V3 through capacitors C19-1 and C19-2.

The fixed coils of the dynamometer type left-right indicator are tuned to resonance at 48 cycles per second and serve as the tuned circuit of the audio oscillator tube V2. Since the left-right indicator has an alternating magnetic field of 48 cycles per second, current in the moving coil at the same frequency, and leading in phase, will produce a deflection of the pointer toward one side of center. If the phase of the current in the moving coil is reversed, the deflection of the pointer will also reverse. Voltage from the audio oscillator is impressed upon the grids of the modulator tube sections in phase opposition through resistors R12-6, R12-7, and capacitors C3-18, C3-19. Due to its characteristics and because of the magnitude of the audio oscillator voltage impressed upon its

grids, the modulator tube functions as an electronic switch, permitting the loop voltage to pass through first one section and then the other. Since the plates of the modulator tube are push-pull connected to transformer T4, the amplified loop voltage is added to the nondirectional vertical antenna voltage when one section of the modulator tube is functioning and subtracted when the other section is functioning. The received signal is thus locally modulated at the frequency of the audio oscillator proportionately to the voltage induced in the loop.

The signal is then amplified and the local modulation is detected and amplified to provide the 48-cycle per second energy for the moving coil of the left-right indicator. The phase of the voltage induced in the loop and the phase of the local modulation reverse as the loop is rotated through a null. This, in turn, reverses the phase of the current in the moving coil of the indicator and changes the deflection of the pointer from one side of center to the other.

When the transmitter is located on the perpendicular to the plane of the loop, there is no voltage induced in the loop consequently no local modulation of the received signal.

---

3. INSTALLATION

3-1. PRELIMINARY INSPECTION

Prior to the installation of any equipment, a thorough visual and, if possible, electrical inspection of all parts should be made in accordance with the procedure listed in Section 4-1.

3-2. BONDING AND SHIELDING

The ultimate sensitivity of any aircraft receiving installation is limited by the magnitude of the local electrical interference, rather than by the actual sensitivity of the receiver as measured in the laboratory. If reception of weak signals is desired, the aircraft engine, charging generator, ignition system, and all electrical accessories must be completely bonded and shielded prior to installation of the equipment.

3-3. LOCATION AND MOUNTING OF RADIO COMPASS EQUIPMENT

See Figures 10 to 14 and 17 for mounting dimensions.

The mounting base to support the radio compass should be firmly attached to a plane surface as close as possible to the vertical antenna lead-in, and near the associated equipment. When determining this location, care must be taken to permit the radio compass to vibrate freely in all directions. After these requirements have been met, and the lower mounting base has been permanently secured, the upper mounting base and dust cover should be attached to it by means of the Dzus fasteners. Mounting dimensions are given on Figure 10.

The Type MN-20A or Type MN-24A Rotatable Loop must be mounted within a 42- to 168-inch cable run of the receiver, and should be as far removed as possible from antennas and interfering metal structures. The preferred locations are on the fore-and-aft center line of the ship, either above or below the fuselage, about where the wings are attached. A mounting plate for the loop should be drilled as shown in Figure 12 and secured to the aircraft structure in such a manner that the loop base will be level during normal flight. Holes should be made in the skin of the aircraft to permit the passage of the rotator mechanism, the loop transmission cable, and the securing bolts. Sufficient clearance should be available inside the fuselage for the attachment and removal of the loop cable and tuning shaft. A velutex or similar, gasket should be used between the loop mounting base and the skin of the aircraft to make a water tight seal.

The Type MN-22A Azimuth Control should be mounted so that the dials are easily readable from the operator's position. Four No. 6-32 screws are required for panel installations; three sets of No. 8-32 screws and nuts will be required for rear (bulkhead) mounting. To enable mounting the azimuth control in that position which facilitates the approach of the tach-shafts and still retain indications relative to ship's heading, the zero positions of the dials may be shifted to any of four 90-degree separated positions. This change of position may be done by removing the snap ring and glass, removing the eight dial holding screws and rotating the dial to the desired position. When replacing the screws, use a small amount of glyptal cement to hold them in place. Such a shift in the zero position of the dials will require resetting the cam. The shafting from the loop should be attached to that azimuth control shaft coupling which causes the pointer to rotate in the same direction as the loop. Zero indication on the outer dial should correspond with the zero bearing of the loop.

The two instrument lamps (Bendix No. A18881-1) have one side grounded so a single wire from the airplane's power source will provide illumination. Connection to the unit is made by means of a Breeze plug No. 1002-15-10 (Bendix No. AB9487). A resistor (A100199-1 for 14V; A10099-2 for 28V) is provided in the unit to reduce the current supplied to the lamps to the proper value.

The Type MN-52A Azimuth Control is arranged for mounting on a flat horizontal or vertical surface in front of, or alongside of the pilot. See Figure 13 for location of mounting holes.

The Type MN-28A Remote Control should be located where the panel will be easily visible and the controls accessible to the operator. Clearance for connection of the mechanical tuning shaft and the electrical cables should be provided. See Fig. 11 for location of mounting holes.

The Type IN-4A Left-Right Indicator is designed to fit standard 3¼-inch instrument panel mounting holes. Space is normally available for

the indicator on the instrument panel near the other flight instruments. Mounting dimensions for the indicator are shown in Figure 14, Clearance must be allowed for the installation of the connecting cable. It will not be necessary to shock mount the left-right indicator if the panel on which it is mounted is provided with shock absorbers. For other installations, shock mounting must be provided.

The warning light may be mounted in any location that is constantly in the pilot's view. See Figure 14. No warning light is used with the MN-22A.

The junction box should be mounted in an accessible location. In the interest of weight reduction of interconnecting cabling, it is well to locate this box as near as possible to the component units. The junction box must be drilled for mounting. Whenever the resistor R41 or the meter field load assembly are used it will also be necessary to drill holes and mount them in the junction box.

3-4. CABLE CONNECTIONS

The equipment and cables must not interfere with the airplane controls or with other instruments or equipment.

The cable conduit and flexible tuning shafts should be securely fastened in place wherever necessary to prevent abrasion or vibration. Cables connecting to the radio compass should be unsupported for a distance of two feet from the unit and should have enough slack left so that they will not interfere with the action of the shock mounting. The loop cable should be insulated with friction tape wherever it touches another metallic surface. All connections are to be made as shown on Figure 9. See Section 2-8 for additional information concerning the cable interconnections. THE LOOP TRANSMISSION CABLE MUST NOT BE CUT, any excess length may be coiled wherever convenient.

The flexible tuning shafts should be bonded to the principal metallic structure of the aircraft at frequent intervals. The minimum bending radius of the tuning shafts is six inches and not more than two six-inch, 90-degree bends should be made in any one cable installation. Several bends of larger radius or greater angles may be permitted, however. The ends of the shafts terminate with spline joints which are securely held in place on the units by threaded collars.

A gear box mounted on the front panel provides means for obtaining the necessary reduction of rotation between the flexible tuning shaft and the tuning condenser. The flexible shaft connects through a spline and shaft to a worm which drives a split spring loaded worm gear provided with stops to limit the amount of rotation to 180 degrees. The hub of this worm gear is tapered to fit onto a similar taper on the gear shaft, pressure for locking the gear onto the shaft being provided by a knurled nut. When this knurled nut is loosened, the shaft may be turned to any setting without turning the gears. An arm that engages the tuning condenser is mounted on the end of worm gear shaft.

The gear box assembly may be mounted at any one of several positions on the front panel to enable the flexible tuning shaft to be run to the unit with a minimum of bending. Should it be desirable to change this gear box position:

A. Connect the tuning shaft and the remote control to the gear box and rotate the tuning crank in a *counterclockwise* direction until the gear box stops prohibit further rotation.

B. Disconnect the tuning shaft from the gear box and remove the six screws holding the gear box and its cover in place.

C. Loosen the knurled nut in the gear box.

D. Be sure that the condenser is set at maximum capacitance.

E. Rotate the gear box to the desired position and fasten it in place.

F. Tighten the knurled nut and replace the cover plate.

G. Turn the remote control tuning crank until the alignment dot is centered under the index (Band III).

H. Reconnect the flexible tuning shaft and check the adjustments by rotating the tuning crank throughout its range to see if minimum and maximum capacitance is obtained at the end points of the dial scale.

To connect the shaft used for receiver tuning:

A. Set the condenser plates at maximum capacitance (against the stop).

B. Turn the band selector switch to Band III (695-1500 Kcs).

C. Turn the remote control tuning dial to the dot designated ALIGN.

D. Connect the shaft to both the remote control and the radio compass.

E. Check the alignment by varying the tuning knob and resetting to maximum condenser setting. The dial should be reset on the alignment dot.

The flexible shaft which links the loop antenna and the azimuth control should be connected so that the plane of the loop is perpendicular to the airplane line of flight when the dial reading is zero. After setting the two units, tighten the shaft securely and check the installation by rotating the azimuth control knob several degrees each way, then resetting to zero. If the mechanical cable has been properly aligned, the dial scale will read zero when the plane of the loop is at right angles to the line of flight.

3-5. ANTENNA TYPES AND CONNECTIONS

The Type MN-26A and Type MN-26C Radio Compass units are designed and adjusted to operate in conjunction with a vertical antenna having an effective height of 0.3 to 0.6 meters, a capacitance between 50 and 100 Mmf, and a resistance

of 1 to 10 ohms. While it is desirable to use an antenna whose characteristics fall within the above limits, satisfactory operation may be obtained with other antennas.

The type of antenna which will be used in any particular installation will be dictated by consideration of space and support structures available on the aircraft.

The portion of the lead-in inside the fuselage should be flexible insulated wire mounted so that the capacitance to ground is at a minimum. If a vertical "spike" antenna is used, the lead-in must have extremely low capacitance and be less than two feet long. A suitable amount of slack must be allowed at the receiver to permit free action of the shock mounting.

---

4. PREPARATION FOR USE

When a radio compass receiver is transferred from one type of airplane installation to another, and particularly if the change involves an alteration in the length of the loop transmission cable, it will be necessary to check the loop capacitor and inductance alignment as explained in Section 6-4-5.

4-1. TESTS BEFORE INSTALLATION IN AIRCRAFT

Considerable time and trouble will be saved if the components of radio compass equipment to be installed in aircraft are interconnected as shown in Figure 9, and tested before installation. If a standard transmission line test set-up is available, the performance of the equipment should be measured in accordance with Section 6-5. If the above test set-up is not available, the components should be properly interconnected and tested as follows: Tune in several radio stations in each band. On each station operate the equipment on the COMP., REC.ANT., and REC.LOOP positions. When operating the equipment on COMP., swing the loop to the right and left and note the degrees of loop rotation required to produce full scale indicator deflection with the COMPASS control set at maximum. This should be approximately 5 to 6 degrees, dependent on the input signal strength. Note the on course and reciprocal bearings. The on course bearings should check geographical bearings within one degree. From a knowledge of the distance, power, and direction of the station a rough check may be obtained of the performance of the equipment. These tests should be made in a frame test shack in an isolated spot free from electrical interference and at least 200 feet distant from large electrically conductive objects such as buildings, hills, power lines, railroads, etc. *Sensing or bearing accuracy checks can not be relied upon if made inside or close to buildings with metal structures or large electrically conductive objects unless radio compass bearings check actual geographical bearings.* The sensing of the radio compass should be such that the indicator pointer points to the station; that is, if the station is to the left of the perpendicular to the plane of the loop, the indicator should point left; if station is on the right, the indicator should point right. The following inspection should be made prior to installation:

A. Check list of parts and see that all parts are in good condition.

B. Insert all tubes in the radio compass unit, making sure that they are firmly seated in their respective sockets and that all grid clips and grid cap shields are pushed down tightly. The absence of grid caps will cause small errors of the left-right indicators.

C. Check safety wiring of dynamotor.

D. Check all lamps and fuses.

E. Check operation of tuning drives and all controls for freedom of operation.

F. Allow the equipment to operate for at least one-half hour. Check operation of headset. Vibrate or jar the equipment. Any clicks or increase in noise will require a thorough investigation and removal of the cause. Improper soldering of wires to the plugs and noisy vacuum tubes are the usual source of trouble.

G. If the equipment does not seem to be operating satisfactorily, the interconnecting leads and vacuum tubes should be rechecked and equipment known to be in operable condition substituted for the faulty component.

4-2. TESTS AFTER INSTALLATION

After the radio compass has been installed in the aircraft, the following tests should be made before placing the equipment into service:

A. Before turning on the radio compass, check the battery voltage and polarity at the remote control. The fuse terminals should be +11 to +15 volts (22 to 30 volts for 28-volt installations) with respect to ground, regardless of engine speed.

B. Check vacuum tubes to ascertain that they are securely seated in their sockets, and that the grid clips and grid shield caps are making positive contact and are not shorting.

C. Test operation of mechanical cables and connections at both local and remote positions. When properly connected, the ALIGN mark on the remote dial is centered with the ganged condenser at maximum.

D. Check radio compass mounting base screws.

E. Check remote control for tightness of mounting to aircraft structures, and check mounting screws on panel for tightness.

F. Check vertical antenna and see that connections are properly and securely made.

G. Be sure that the loop transmission cable is supported, taped, and bonded. Check tightness of ferrule couplings on the plugs.

H. Check for presence and operation of instrument lights. Also check lamp controls.

I. Using a headset, check receiver operation on all three bands, then check compass operation and indicator response. Jar the compass unit to check for possible sources of noise.

J. Switch compass on and off and note whether or not the airplane's magnetic compass is affected.

K. Check for effects of other radio equipment in the aircraft upon the communicational and navigational performance of the radio compass. Also determine the extent of any interference produced by the radio compass in other radio equipment.

L. Turn OFF-COMP.-REC.ANT.-REC.LOOP switch to COMP. and head the plane toward a transmitting station of known direction. The azimuth control should be set for a 0 azimuth dial reading to give on-course indications. Turn the azimuth control about 15 degrees to the right of the transmitting station and observe the indicator. The pointer should deflect toward the left of the dial. Repeat test, turning the azimuth control 15 degrees to the left of the transmitting station. The indicator pointer should deflect to the right of the dial. If the sense indication is wrong; disconnect the mechanical cable from the azimuth control, rotate the azimuth control 180 degrees, and connect the mechanical cable onto the control unit.

M. With AUDIO control at maximum, tune through each band with the engine stopped and note the noise level. Repeat test with the engines running at various speeds. If any appreciable increase in noise is noted with the engines running at any speed, the aircraft shielding and bonding and the battery circuit filtering should be improved.

4-3. LOOP GAIN ADJUSTMENT

The function of the loop gain control R1 is to provide the proper ratio of loop signal to vertical antenna signal. The control is located on the left side of the compass unit chassis. See Figure 3. The adjustment procedure is as follows:

A. Take the airplane to a place removed from buildings, power lines, fences, etc. If the vertical antenna used with the compass unit is installed underneath the fuselage of the aircraft, the adjustments should be made while the aircraft is in flight, as the pick-up of the vertical antenna will be affected by its proximity to ground.

B. Turn loop gain control fully counterclockwise and set the OFF-COMP.-REC.ANT.-REC. LOOP switch at the COMP. position.

C. Tune in a strong signal and rotate the loop until on-course indication is obtained on the left-right indicator.

D. Rotate loop 90 degrees and back off on the compass control until a less than full-scale deflection is obtained.

E. Turn loop gain control slowly in a clockwise manner until further clockwise adjustment no longer results in increased indicator deflection, readjusting the compass control if necessary to keep the indicator needle within scale limits.

4-4. THRESHOLD SENSITIVITY ADJUSTMENT

The threshold sensitivity control is mounted in the MN-28 remote control unit. After the loop gain control has been adjusted, with the threshold sensitivity control turned fully clockwise, tune the receiver to the point of maximum noise and meter deflection with no signal applied. This should occur in the low frequency band. (This test should be conducted in a location that is as free as possible from interference or static in order that the amount of externally generated noise be at a minimum.) Turn the threshold sensitivity control R2 counterclockwise until the indicator deflection is not over three quarters full scale.

4-5. QUADRANTAL OR AIRCRAFT ERROR CALIBRATION

4-5-1. General

Distortion of the radio frequency field pattern in the vicinity of the aircraft is due to wings, fuselage, engines, propellers, antennas, and other parts of the aircraft. This distortion makes it necessary to check the direction of radio bearings at intervals of 15 degrees or less with respect to the fore-and-aft axis of the aircraft. Errors determined by a calibration check may be compensated in the Type MN-22A Azimuth Control so that the readings correspond to the direction of the radio bearing, provided the errors do not exceed ±20 degrees.

Calibration may be made on the ground if the loop is mounted on top of the aircraft, but the accuracy of the calibration should be checked in the air. The accuracy of a ground calibration of an aircraft having the loop mounted on the bottom may be affected by the proximity of the loop and vertical antenna to the ground. Such a calibration should be considered only approximate until checked in the air.

Aircraft error increases with frequency so that the greatest errors will occur at the highest frequencies used for radio compass operation. Consequently, calibration should be made on at least one station in each band and on frequencies most generally used, where greatest accuracy is required. Accurate bearings may generally be obtained on stations in the frequency range from 200 to 1000 Kcs. The error caused by a change in frequency from 200 to 1000 Kcs. should not usually exceed 3 degrees. When calibration data obtained at the midpoint of this range is used for compensation of the loop, bearings read directly from the azimuth indicator at any other frequency between 200 and 1000 Kcs should not generally be in error by more than 2 degrees. Errors due to sharp discontinuities in the quadrantal error

curve will be variable with frequency. These discontinuities are probably caused by resonant structures (usually antennas), and it is important that the loop be so located with respect to such structures that the quadrantal error curve is smooth and essentially sinusoidal.

4-5-2. Radio Compass Calibration On The Ground

4-5-2-1. General

The calibration may be made on the ground by one of two methods; either by moving a portable radio transmitter around the aircraft at a distance of at least 1000 feet in a clear and open field, or by using a fixed radio station and turning the aircraft on a compass rose.

Checks should be made at 15-degree intervals, or at 10-degree or 5-degree points if greater accuracy is required.

4-5-2-2. Portable Transmitter Method

The procedure to be followed when a portable radio transmitter is moved around the aircraft is as follows:

A. Locate the aircraft in the center of a clear and open field at least 2000 feet in diameter. The aircraft must be in flying position.

B. Locate a portable transmitter in line with the fore-and-aft axis of the aircraft so that the aircraft heads towards the transmitter. Use an accurate means of alignment such as an engineer's transit, or pelorus, located on top of the aircraft. The portable transmitter should have sufficient power (5 to 100 watts) to override any external interference and should use a vertical rod or mast 10 to 50 feet high for an antenna.

C. Set the transit or pelorus to zero degrees when the line of sight from the pelorus to the transmitter coincides with the center line of the aircraft.

D. Tune the radio compass in the aircraft to the frequency of the portable transmitter. Choose a transmitter frequency free of interfering signals, and preferably in the frequency range that will be used most of the time for radio bearings.

E. Rotate the loop until on-course indication is obtained. The bearing reading of the azimuth indicator should be zero if previous adjustments were made correctly. Record this reading for the zero heading of the aircraft on a form similar to that shown in Figure 19.

F. Move the portable transmitter, at a radius of at least 1000 feet, through an angle of 15 degrees with respect to the axis of the aircraft, as determined by the line of sight of the transit or pelorus mounted on the aircraft. Rotate the loop until on-course indication is obtained on the left-right indicator. Note and record the reading of the azimuth indicator for the 15-degree position of the transmitter.

G. Move the transmitter 15 degrees from its position in F above at a radius of at least 1000 feet so that the line of sight from the aircraft to the transmitter makes an angle of 30 degrees with the axis of the aircraft. Rotate the loop until on-course indication is obtained. Note and record the reading of the azimuth indicator for the 30-degree position of the transmitter.

H. Repeat the above procedure for transmitter positions at 15-degree (or less) intervals until the transmitter has been moved through 360 degrees around the aircraft.

I. Plot a correction curve of the results obtained on the graph sheet (Figure 22) or similar graph paper. Figure 21 is an example of a typical correction curve. The correction curve obtained may be used to compute the correction necessary when a Type MN-52A Azimuth Control is used. If a Type MN-22A Azimuth Control is used, the curve may be employed to plot cam correction points as described in Section 4-5-4.

J. Repeat the calibration for different frequencies. Be sure to indicate the calibrating frequency on each calibration curve obtained.

4-5-2-3. Fixed Transmitter Method

Calibration of the equipment on the ground from a fixed radio station may be made at the same time the magnetic compass is calibrated and may be accomplished as follows:

A. Locate the aircraft on a compass rose. The aircraft must be in flying position. The general location should be clear of all buildings or obstructions. If a compass rose is not available, one accurate heading toward the selected radio station must be determined and means provided for measuring the angle of aircraft heading with respect to the radio station heading. This angle may be measured by using a transit or pelorus set up on top of the aircraft and sighting on some fixed object at least 1000 feet distant from the aircraft.

B. Select a high-powered, clear-channel radio station from 10 to 100 miles distant, or use a suitable portable transmitter as described for the preceding method. The station should normally provide good bearings with practically no fluctuation of the left-right indicator needle.

C. Tune the radio compass receiver to the transmitter frequency used, and accurately head the aircraft toward the transmitter. Rotate the loop for an on-course indication on the left-right indicator needle. Set the azimuth scale zero mark on the MN-22A to the zero index mark. Note and record the pointer reading of the azimuth indicator for the zero-degree heading of the aircraft. The azimuth indicator reading should be zero degrees if the installation and all adjustments have been made correctly.

D. Swing the heading of the aircraft through an angle of 15 degrees (or less) from the original zero heading above. Rotate the loop for an on-course indication. Note and record the bearing reading of the azimuth indicator for this heading of the aircraft. If the aircraft is turned to the left (counterclockwise as seen from above), the azimuth indicator reading should increase.

E. Increase the heading of the aircraft by 15 degrees so that a heading of 30 degrees with respect to the original zero heading is established. Rotate the loop for an on-course indication. Note and record the pointer reading of the azimuth indicator.

F. Repeat the above procedure for every 15-degree increase in heading of the aircraft until the aircraft has been turned through 360 degrees.

G. Plot a correction curve of the results obtained on the graph sheet (Figure 22) or similar graph paper. Figure 21 is an example of a typical correction curve. The correction curve obtained may be used to compute the correction necessary when a Type MN-52A Azimuth Control is used. If a Type MN-22A Azimuth Control is used, the curve may be employed to plot cam correction points as described in Section 4-5-4.

H. Repeat the calibration for different frequencies. Be sure to indicate the calibrating frequency on each calibration curve obtained.

4-5-3. Radio Compass Calibration In The Air

The procedure for calibration in the air is similar to that previously outlined for ground calibration, since azimuth indicator readings are noted for definite headings of the aircraft with respect to a given transmitter. A high-powered, clear-channel radio station having a vertical radiator should be selected for use in calibrating. The station should provide good bearings with little or no fluctuation of the left-right indicator needle. Do not make the calibration within one hour of sunrise or sunset or when interference or wide fluctuations in bearings are noted. The calibration should be made over smooth terrain if possible in order to avoid reflected or distorted radio waves. A clear day with winds less than 8-10 miles per hour and when the air is smooth should be chosen for a calibration flight in order to eliminate errors due to drift, variations in the heading of the aircraft, and errors in reading the indicator and gyro. All turns made during the calibration procedure should be uniform and gradual so that the directional gyro is not disturbed more than absolutely necessary. Radio bearings should only be taken with the aircraft in level flight and not during a turn or in a bank. Practical use of the radio compass equipment for navigational purposes depends on the accuracy of the calibration, hence the necessity of accurate procedure in flight calibration cannot be overemphasized.

Calibration may be accomplished in the air as follows:

A. Select a series of landmarks that will provide a direct line toward a suitable radio station 25 to 100 miles distant. A road, railroad, power line, or section line makes a good reference line. Distortion of the radio field caused by structures on the reference line (a power line for example) should be checked by noting the action of the left-right indicator as the aircraft is flown on a steady heading across the reference line and as the loop is kept on course. If irregularities occur in the radio bearing indication as the line is approached, or crossed, distortion of the radio wave is present and should be eliminated by flying at a higher altitude or using a different location.

B. Head the aircraft toward the transmitter while flying directly over and along the reference line. Fly at an altitude low enough to avoid sighting error, and keep the aircraft in level flight. Set the directional gyro to zero and rotate the loop to obtain on-course indication of the left-right needle. Release the gyro caging knob so that the directional gyro reads zero when the heading of the aircraft coincides with the ground reference line. Note and record the reading of the azimuth indicator for this zero-degree heading of the aircraft. The indicator reading should be zero degrees if there is no drift and if all adjustments have been properly made.

C. Refer to Figure 18 for a diagram of the flight procedure to be used. After the reading for the zero heading is obtained, turn the aircraft to the left and fly far enough from the reference line so that the aircraft may be turned to the right and a gyro heading of 15 degrees established before the reference line is crossed. With the aircraft held in level flight on a steady gyro heading of 15 degrees, observe the azimuth indicator reading when the aircraft is exactly over the reference line, with the loop rotated for an on-course indication. Record this reading on a form similar to Figure 20.

D. Fly to the right of the reference line far enough so that a left turn may be made and a gyro heading of 345 degrees established before the reference line is recrossed. Note and record the azimuth indicator reading when the aircraft is exactly over the reference line in level flight and on a steady gyro heading of 345 degrees, with the loop held for an on-course reading.

E. Repeat C and D above for gyro headings of 30 and 330 degrees. After the azimuth indicator reading is obtained for the 330-degree gyro heading, execute a right turn so that the aircraft is heading away from the transmitter and flying directly over the reference line.

F. Check the directional gyro reading when the heading of the aircraft coincides with the reference line, flying away from the transmitter. The gyro should read within several

degrees of 180 if all turns have been carefully made. If considerable precession of the directional gyro is noted when the 180-degree reference line course is checked, it is recommended that the procedure be repeated or the dirctional gyro checked, if necessary. Small differences due to normal creeping of the gyro (approximately 3 degrees or less over a period of 15 minutes) may be proportioned to each heading.

G. Recage the directional gyro to 180 degrees while the aircraft heading coincides with the reference line, release the caging knob and record the azimuth indicator reading for the 180-degree heading with the aircraft in level flight and on a steady course over the reference line, with the loop positioned for an on-course indication.

H. Following a procedure similar in general to that given above, obtain azimuth indicator readings for gyro headings of 195, 165, 210, and 150 degrees. Turn the aircraft to head toward the transmitter along the reference line, establish a zero-degree heading with respect to the reference line, check the gyro reading as in F above, and recage the gyro to zero degrees.

I. Continue to fly to and from the transmitter over the reference line, alternating the headings of the aircraft from left to right until azimuth indicator readings have been obtained for every 15-degree change in heading of the aircraft.

J. Record the data obtained on a form similar to Figure 20. Plot a correction curve on the graph sheet (Figure 22) or similar graph paper. Figure 21 is an example of a typical correction curve. The correction curve obtained may be used to compute the correction necessary when a Type MN-52A Azimuth Control is used. If a Type MN-22A Azimuth Control is used, the curve may be employed to plot cam correction points as described in Section 4-5-4.

K. Repeat the calibration for different frequencies. Be sure to indicate the calibration frequency on each calibration curve obtained.

L. If greater accuracy is required, use 5-degree or 10-degree increments for changes in heading instead of 15 degrees. Do not make more than four alternate bearing checks between any two zero-degree and 180-degree gyro checks, unless it can be proven that more than four checks can be made without introducing excessive errors. If the reference line is not long enough, or if difficulty is experienced in checking the zero-degree and 180-degree gyro headings of the aircraft against the reference line after a series of turns, reduce the number of alternate right and left headings of the aircraft from four to two or even one.

CAUTION: *Any metallic masses, structures, or conductors in which circulating RF currents may be induced, if later added, removed, or altered in the field of the loop may destroy the accuracy of the calibrations. This applies to the bonding of the airplane, relocation of wiring or of shielding, and spare parts or gear stowed near the loop. Check the calibration in flight at frequent intervals by taking bearings on stations of known direction. The corrected indicated radio bearing, added to the corrected magnetic heading, should give the actual magnetic bearing to the transmitting station.*

4-5-4. MN-22A Cam Shaping

If an MN-22A Azimuth Control is used, the cam must be cut so that corrected bearings may be read directly from the azimuth indicator. Since the cam is cut for one frequency only, it should provide correction at the most generally used frequency. In most instances, the errors will hold to within one or two degrees over the frequency range of 150 to 1500 Kcs.

Before cutting the cam prepare a correction curve as follows:

A. Determine the azimuth indicator corrections from the quadrantal error data. The correction will be the difference between the *True Radio Bearing* and the *Observed Radio Bearing*. If the *True Radio Bearing* is greater than the *Observed Radio Bearing*, the correction will be positive (negative error). If the *True Radio Bearing* is less than the *Observed Radio Bearing*, the correction will be negative (positive error). Use the blank calibration sheet (Figure 20) included in this book to record corrections. A typical set of quadrantal error data is shown as an example in Figures 19, 21.

B. Plot a correction curve similar to that shown in Figure 21. Plot corrections against the corresponding *Observed Radio Bearing* values. Do not plot the corrections against the *True Radio Bearings* or *Gyro Headings*. Be certain that the signs of the corrections are correct.

C. If this curve is essentially symmetrical and sinusoidal (corrections not exceeding ±20 degrees, and the change in correction from any 15-degree point to the adjacent 15-degree point not exceeding 10 degrees), the corrections can be compensated for on the compensator cam. If the errors exceed ±20 degrees and the curve is sinusoidal, corrections up to 20 degrees may be compensated for on the compensator, but it will be necessary to apply any corrections over 20 degrees by using a correction curve. If there are sharp discontinuities in the curve (rate of change of correction exceeding 10 degrees in 15 degrees of azimuth), it will be necessary to determine the cause of such errors and remove this cause. It will then be necessary to rerun the quadrantal error calibration. Should antennas or the aircraft structure be changed in any way after a calibration has been made, it will be necessary to rerun the calibration.

D. Determine the corrections to be applied at each 15-degree point on the cam scale by

noting the reading of the curve at each 15-degree interval on the correction curve. Record these corrections on a form similar to Figure 20. *Note that the correction values to be applied to the compensator are not those determined from the flight calibration.*

Disassemble the cam assembly as follows:

NOTE: *Before uncoupling the loop tach-shaft, preparatory to removing the azimuth control, set the pointer on zero. Make sure that the shafting does not rotate from this position during the time in which the azimuth control is uncoupled.*

A. Remove the back cover by unfastening the six screws.

B. Remove the cam supporting bracket.

C. Unscrew the cam holding nut and remove the cam blank N5 from the cam bracket.

The azimuthal bearings of the loop are indicated on the cam blank by the radial lines spaced 15 degrees apart. The circles on the cam represent degrees of correction and the distance between each circle is equivalent to 5 degrees. It will be noted that the maximum plus correction of 20 degrees is the outside diameter of the cam (for correction of minus 20° quadrantal error). A plus correction, advances the indicator pointer relative to the loop.

With a sharp pointed scribe, lay out on the cam blank the contour indicated by the curve drawn on Figure 22. The correction to be applied on the 45-degree line is obtained by reading the intersection of the plotted calibration curve with the vertical 45-degree line on the *Observed Radio Bearing* scale. For example, if this is found to be plus 15 degrees a mark would be made on the cam at the point where the 45-degree radial line intersects the plus 15 degrees correction circle. A point should be marked at each radial line. Scratch a smooth connecting line through all the points. This line represents the contour of the cam. Sudden breaks in the contour usually indicate that a mistake has been made and the cam layout at these points should be checked. Using first a coarse and then a fine file, carefully file away the cam to the contour line. The edge of the cam should be smooth and free from file marks.

Reassemble the cam in the cam bracket with a lockwasher and nut. Do not fully tighten the nut. Assemble the cam bracket in the casting making certain that the cam follower pin is in contact with the edge of the cam. Keep the pointer at zero degrees on the dials and adjust the cam so that the zero-degree radial line is lined up with the mark on the cam follower pin. Tighten the nut.

To check the cam assembly and contour, refer to the calibration curve. Set up the loop azimuth bearings as indicated on the cam by the cam follower pin, by revolving the coupling shaft. The pointer should read the corresponding true bearings. Settings hidden from view by the cam holder can be checked by counting the revolutions of the coupling shaft, as one complete turn of this shaft rotates the cam follower pin 3 degrees. Reassemble the back cover.

If installation requirements have made it necessary to shift the zero position of the dials after the cam has been calibrated and filed, the cam will have to be set so that the cam follower pin is at zero on the cam when the pointer is at zero on the dials.

Before recoupling the indicator to the loop shaft, set the pointer on zero and make certain that the loop has not shifted from its zero-degree heading.

4-6. PERFORMANCE TESTS

4-6-1. Normal Radio Reception

To check normal radio reception:

A. Set master switch on the remote control box to REC.ANT.

B. Plug a telephone headset into TEL jack.

C. Turn AUDIO control to maximum.

D. Allow about forty seconds for the tube heaters to reach their operating temperature.

E. Turn band selector switch to 150-325.

F. Operate the TUNING control until a signal is heard.

G. Vary AUDIO control and note if smooth reduction of volume is obtained.

H. Tune in several stations and note if the selectivity is good.

I. Turn band selector switch to Bands II and III each time checking AUDIO control action and selectivity on several stations.

4-6-2. Anti-Static Radio Reception

To check anti-static reception:

A. Set master switch to REC.LOOP.

B. Repeat steps B, C, D, E, and F of Section 4-6-1.

C. Operate azimuth control until maximum signal is heard in the earphones.

D. Repeat steps G, H, and I of Section 4-6-1, each time operating the azimuth control until maximum signal is heard in the earphones.

4-6-3. Direction Finding

To test direction finding performance:

A. Set master switch to COMP.

B. Set plane in flying attitude headed accurately toward true north.

C. Tune in the signal from a weak station of known direction and rotate the azimuth control until on-course indication is obtained on the left-right indicator, noting whether the azimuth control reading as corrected for deviation corresponds with the known direction of the transmitting station.

D. Turn aircraft to any other known direction and repeat the procedure C, above. Sufficient checks from different positions must be taken to assure that the azimuth control reading and deviation calibration is correct.

5. OPERATION

5-1. GENERAL

The master control switch marked OFF, COMP., REC.ANT., and REC.LOOP controls all radio compass equipment functions other than tuning and adjustment of signal level.

The COMP. setting is used for obtaining communications reception, visual on-course indication of homing and bearings.

The REC.ANT. setting is used for communication and aural radio range reception.

The REC.LOOP setting is used for obtaining communications reception during conditions of severe rain and snow static, aural radio range reception, aural null bearings, and aural null homing from communication stations.

The OFF setting opens all current consuming circuits thus rendering the equipment inoperative.

The azimuth control warning light operates at all times when the equipment is in use except when the azimuth control is set at zero.

5-2. COMMUNICATIONS RECEPTION

5-2-1. General

The MN-26A or MN-26C Radio Compass Equipment may be used for normal reception of communications using a fixed antenna or, in times of extreme rain or snow static conditions, the loop antenna may be used in place of the vertical antenna for anti-static reception. Anti-static reception is not used at all times because of the lower over-all sensitivity when using the loop only.

5-2-2. Normal Reception (antenna)

A. Turn master switch to REC.ANT.
B. Select desired frequency range.
C. Snap C.W. switch ON or OFF as desired.
D. Tune in station.
E. Adjust AUDIO control for desired headset volume.

The COMPASS control and azimuth control are not used for reception of communications.

5-2-3. Anti-Rain-Static Reception (loop)

The operating procedure is as follows:

A. Turn master switch to REC.LOOP.
B. Select desired frequency range.
C. Snap C.W. switch ON or OFF as desired.
D. Tune in station.
E. Rotate azimuth control for maximum output in headset.
F. If the station is to the left or right of the airplane's course, it will occasionally be necessary to readjust the azimuth control setting for maximum signal.
G. Adjust AUDIO control for desired headset volume.

5-3. HOMING

5-3-1. Radio Range Reception

It is necessary either to have a map showing the radio range course and characteristics, or to know the location of the course and its characteristic A and N signal areas.

The operating procedure is as follows:

A. Turn master switch to REC.ANT.
B. Turn band switch to 150-325 Kcs.
C. Tune to desired frequency.
D. Adjust AUDIO control to desired signal level.
E. Obtain a fix of position, see Section 5-4-4, thus determining the direction to the course it is desired to follow.
F. Turn plane so as to intercept the radio range course.
G. The A and N signals will blend into a continuous dash interrupted by the station identification when on course.
H. The plane may then be flown on course to the location of the radio range station.

Arrival at destination is indicated by an abrupt decrease in headset volume known as the cone of silence.

A radio range course may also be flown with anti-rain-static reception in which case the master switch would be set on REC.LOOP and the azimuth control rotated for maximum signal strength at approximately 90-degree or 270-degree settings.

5-3-2. Visual Radio Compass Homing

The operating procedure is as follows:

A. Set azimuth control at zero. *The warning light must be off.*
B. Adjust COMPASS control to maximum.
C. Turn master switch to COMP.
D. Select desired frequency range and tune in station.
E. Listen carefully for station identification to be sure that the desired station is being received. AUDIO control may be set for any audio output level without affecting the deflection of the left-right indicator needle.
F. Alter the airplane's course to left or right as shown by the left-right indicator needle until reading is zero or on course.
G. Although on-course indications will be obtained both when approaching and when flying away from a transmitter no confusion as to location of the station need result. If a course correction, to the right for example, is accompanied by a deflection of the indicating needle in the same direction, the station is aft, while if the deflection is in the opposite direction, the station is ahead. The indicator needle points in the general direction of the transmitting station.

H. Reduce COMPASS control setting until an intermediate value has been found which permits following the course accurately without continuous hunting.

5-3-3. Aural Null Homing

Aural null homing may be used in place of visual radio compass homing should any of the compass circuits or indicator be inoperative or in case of severe rain static. This method is not so desirable as radio compass homing because of the possibility of 180 degrees ambiguity of direction.

The operating procedure is as follows:

A. Turn master switch to REC.LOOP.

B. Select desired frequency range and tune in station.

C. Listen carefully for station identification.

D. When homing on weak signals, turn C.W. switch ON.

E. Adjust AUDIO control for the desired audio level.

F. Rotate azimuth control of zero. *The warning light, if used, must be off.*

G. Turn airplane until headphone volume decreases to minimum.

H. Fly plane on this null course until desired position has been reached.

5-4. DIRECTION FINDING

5-4-1. Visual Bearings

The operating procedure for obtaining radio compass bearings is as follows:

A. Turn master switch to COMP.

B. Adjust COMPASS control for desired sensitivity.

C. Select frequency range and tune in desired station. Check station identification to be sure of having correct station.

D. Observe left-right indicator needle; if needle points toward the right, rotate loop for an increasing azimuth control dial reading, or if it points toward the left, rotate loop for a decreasing azimuth control reading, continuing rotation until an on-course indication is obtained.

E. Observe reading of the azimuth control dial which is relative to the airplane line of flight.

F. Observe actual magnetic heading from the corrected ship's compass reading.

G. Correct azimuth control reading for deviation and, if a Type MN-52A Azimuth Control is used, add corrected reading to actual magnetic heading. Subtract 360 if the sum permits. The final figure will give the true magnetic bearing of the transmitting station with respect to the position of the airplane. To correct this bearing to the magnetic bearing of the airplane with respect to the station, for plotting on a chart, add 180 degrees.

5-4-2. Aural-Null Bearings

Should the left-right indicator or radio compass circuits be inoperative, bearings may be obtained by aural null methods.

The operating procedure is as follows:

A. Turn master switch to REC.LOOP.

B. Select desired frequency range and tune in station. Check station identification.

C. When taking bearings of weak signals, it is helpful to use the CW oscillator beat note.

D. Adjust AUDIO control for desired audio level.

E. Rotate azimuth control until headset volume decreases to minimum.

F. Observe reading of azimuth control dial which is relative to the airplane line of flight. flight.

G. Observe actual magnetic heading from the corrected ship's compass reading.

H. If a Type MN-52A Azimuth Control is used, correct azimuth reading for deviation and add corrected reading to the actual magnetic heading. Subtract 360 if the sum permits. The final figure will give either the true magnetic bearing of the transmitting station or its reciprocal, with respect to the position of the airplane.

5-4-3. Direction Finding Precautions

When for any reason, broadcast station carriers are being used for obtaining bearings, care must be exercised in the selection of stations. Two stations operating on the same frequency may tend to indicate more than one direction, or may fail to give any indication of direction whatever. Stations operating on clear channels will always give the most satisfactory results. Note that broadcast transmitting stations are often situated a considerable distance outside of cities controlling them.

Night effect, or reflection of the radio wave from the sky, is always present. It may be recognized by a fluctuation in bearings.

Try the following to eliminate night effect:

A. Increase altitude thereby increasing the strength of the direct wave.

B. Take an average of the fluctuations.

C. Select a lower frequency station.

Night effect is worse at sunrise and sunset. Night effect is present on stations at 1500 Kcs at distances greater than 20 miles, and as the frequency decreases the distance increases until at 200 Kcs the distance will be about 200 miles. Satisfactory bearings, however, will often be obtained at much greater distances.

5-4-4. Position Fix

A fix of position may be obtained by plotting two or more bearings on a map observing the intersection of the bearings. An alternate method used when homing on a radio range beacon requires only one bearing and the known direction of the radio range course, the intersection of the two projected lines giving the location.

6. MAINTENANCE

6-1. LUBRICATION

Do not lubricate the variable tuning capacitor, potentiometers, or dynamotor commutator. Band switch motor MO is permanently lubricated and will not require attention, unless it is disassembled, in which case the bearings should be repacked with low temperature grease. If the dial gear mechanism is disassembled, the ball bearings should be repacked with low temperature grease.

6-2. ROUTINE INSPECTIONS

6-2-1. PRE-FLIGHT INSPECTIONS

Regular inspections should be made preceding each flight as follows:

A. All interconnecting cables should be checked to see that they are securely locked in their receptacles.

B. Check airplane battery with a hydrometer.

C. Check operation of the voltage regulator on the charging generator, adjusting same to insure consistent operation of the generators at 14 to 15 or 28 to 30 volts.

D. Clean antenna insulators, especially any which may be exposed to engine exhaust or propeller blast.

E. Check connections of lead-in wires, both at antenna and radio compass ends.

F. Check all instrument lamps.

If radio compass is functioning properly with power supply "background noise" at a suitable low level, do not disturb the power supply unit.

Each inspection should include a listening test made on at least one point in each band. Operation of all controls should also be checked. Any major trouble should be apparent from these tests.

6-2-2. PERIODIC INSPECTION

6-2-2-1. General—Applicable to all parts

Inspect all nuts, bolts, and screws for looseness. Do not tighten or loosen glyptalled screws or nuts unless it is evident they are loose. In the event they are loose, remove screws or nuts, glyptal, replace and tighten. Remove loose solder, dirt, and metallic chips. Clean equipment thoroughly and touch up scratched paint. Inspect soldered joints. Inspect wiring. Inspect all plug connectors and clean if necessary.

6-2-2-2. Radio Compass Unit

A. Inspect unit as described in Section 6-2-2-1 but do not disturb alignment adjustment. Do not disturb wiring unless necessary.

B. Check all tubes. If the tube plate current is less than 80% of normal plate current with 6.3 volts on heater, replace the tubes. Replace all tubes used over 500 hours.

C. Dynamotor DYN. The dynamotor should be inspected after 500 hours of service or once a year, whichever period is shorter. Examine the brushes to see if they have worn properly and are free of hard spots. If such spots are apparent, renew the brush. Spotted brushes can be located by inspecting the commutator for grooves. Remove bearings from armature, clean with penetrating oil and carbon tetrachloride. Check bearings for tolerances and broken or chipped balls. Clean away all old grease and relubricate. Wipe off dirt from commutator, end bells, armature, and housing. If commutator does not have a smooth, even surface, place the armature in a lathe and rotate it. Polish the faulty commutator with a piece of soapstone or take a very thin (.003 inch) cut on a lathe. Do not use sandpaper as this causes deformation of the commutator bars. *Do not use emery cloth.* Remove all dust and dirt particles after polishing. A commutator should have a smooth, polished surface free of dirt, grease, or ridges. *A commutator having a smooth or polished surface should not be turned down simply because it is discolored.* Under normal conditions, the commutators should not require turning down before the expiration of 5000 hours of service. After turning down, the commutators should be carefully examined to see if undercutting of mica is necessary. A small brush, such as a toothbrush, should be used to remove any foreign particles that remain between the commutator bars.

D. Tuning Mechanism. Remove all dirt and old grease. Lubricate gear and tuning shaft coupling as specified in Section 6-1.

E. Tuning Capacitors. Inspect for dirt between plates. *Carefully* clean with a pipe cleaner. *Do not bend plates. Do not lubricate.* Do not blow out as air hose may contain water and sufficient pressure to bend the plates.

6-2-2-3. Remote Control

Inspect as indicated in Section 6-2-2-1. Clean and lubricate dial tuning mechanism and tuning shaft coupling as in Section 6-1.

6-2-2-4. Loop

Clean off all grease and dirt. Relubricate if necessary as specified in Section 6-1.

6-2-2-5. Left-Right Indicator

Inspect visually. Replace faulty indicators. Do not open inner case. A faulty capacitor can be replaced by removing outer case only. Repairs of indicators should only be done by competent personnel at authorized instrument repair shops.

6-2-2-6. Test Performance

Reassemble equipment and measure performance as described in Section 6-5. Vibrate equipment and note any increase in noise or clicks with and without RF input. If equipment is noisy or fails to meet performance requirements, reexamine the equipment until the trouble is discovered.

6-2-2-7. Wiring

Inspect bonding in aircraft. Inspect dynamotor safety wiring. Reassemble equipment and safety wire. Inspect antenna lead-in. Make replacements wherever necessary. Inspect the loop mounting for proper bracing.

Repeat operational inspection of Section 6-2-1.

6-3. SERVICING DATA

6-3-1. Trouble Location and Remedy

When one trouble has been found and remedied, check the equipment for proper operation. If unsatisfactory results are obtained, follow from the beginning the procedure outlined below to locate further sources of trouble.

Before removing the equipment from the aircraft, make the following checks:

A. Ascertain that the fuse in the remote control is not burned out, and that battery voltage is normal.

B. See that all cables are connected.

C. Make sure that the nondirectional vertical antenna and lead-in are not grounded or open.

6-3-1-1. Low Compass Output—All Bands

A. Test Receiver Output. Operate the radio compass with the OFF-COMP.-REC.ANT.-REC. LOOP switch in REC.ANT. position. Tune to stations in each band and note whether trouble is experienced on only one or two bands. If so, proceed as outlined in Section 6-3-1-2. If the equipment operates satisfactorily as a receiver on all bands, check REC.LOOP operation of the equipment. If the equipment operates satisfactorily under both conditions, the trouble must be associated with the compass circuits. Proceed as outlined in the following paragraphs. If, however, the REC.LOOP operation of the equipment is unsatisfactory, proceed as outlined in Section 6-3-1-4. If trouble is encountered on all bands, proceed as outlined in Section 6-3-1-3.

B. Normal Receiver Output (antenna or loop). When normal, REC.ANT. and REC.LOOP operation is obtained on all bands, the trouble must lie in the compass circuits and tests outlined in the following paragraphs should be made in sequence.

C. Audio Oscillator Test. With a vacuum tube voltmeter, measure AC voltage between ground and terminals 3 and 5 of the indicator. A .1 Mfd, 400-volt capacitor should be connected in series with the voltmeter. If the AF oscillator stage and the indicator are functioning properly, there will be an AC voltage of from 18 to 22 volts between ground and terminals 3 and 5.

D. Compass Output Amplifier Test. Test the tube V12 for emission and characteristics. Set the OFF-COMP.-REC.ANT.-REC.LOOP switch in COMP. position. Measure the socket voltages on the above tube and compare the readings obtained with the values given in the table in Section 6-3-2. If considerable variation is noted from the typical values, check wiring and components of the circuits associated with the tube elements. Disconnect the compass indicator. Turn COMPASS control full on and apply a 1.5-volt, 48-cycle signal from an audio oscillator between ground and the junction of C7 and R32. Connect an output meter between terminals 3 and 4 of compass output transformer can T16. If this stage is functioning properly, it should be possible to obtain an output of at least 5 milliwatts. If the transformer is defective, the entire transformer can assembly must be replaced. Check C7 for open or short circuit.

E. Left-Right Indicator Test. Check indicator and its associated cables for opens, shorts, and poor contacts. If the tests outlined above show no voltage across the indicator field with indicator connected, check the meter and its resonating condenser for shorts. When one indicator is being used, check the meter field load assembly for shorted or open conditions. If two left-right indicators are used, check one at a time by disconnecting the other and inserting the meter field load assembly supplied with the indicator in its place. If the moving coil of the indicator is intact, check between indicator terminal 4 and compass output transformer terminal 4 for open circuit. Proceed with tests outlined in Section 6-5.

6-3-1-2. Low REC.ANT. Output—1 or 2 Bands

If operation of the receiver is obtained on one or two bands, the necessity of checking operation of IF, 2nd Detector, Audio, etc., circuits is unnecessary as it is obvious that these stages must be functioning to permit operation of at least one band. Proceed to the tests outlined in Section 6-3-1-3.

6-3-1-3. Low REC.ANT. Output—All Bands

A. Miscellaneous. When both signal and noise output are low or absent, first check all external cable connections, including antenna connections, power supply connections, fuses, and headphone connections. Also, remove the cover of the antenna switching relay assembly and check operation of the relay R18, C21-1, and the relay contacts.

B. Remote Control Unit. Remove the remote control from its base and check the wiring, components, and switch contacts for opens, shorts, and grounds. Continuity tests should be made back through the cable and junction box to the plug at the radio compass.

C. Power Supply. Failure of the primary power source may normally be detected by failure of the instrument lamps. The supply voltage (approximately 14 or 28 volts) should appear across the yellow and black leads under the hash filter cover. If no supply voltage appears at this point, check the continuity of the wiring and the contacts of S8.

If supply voltage is normal, approximately 200 volts should appear across the red and black leads under the hash filter cover. If this voltage is unreasonably low, check for short circuits in wiring or components associated with or connected to the high voltage supply. Lack of dynamotor output voltage, if the primary supply voltage is normal, indicates a defective dynamotor.

D. Tubes. Test all tubes for emission and other characteristics. Any tubes not having characteristics within standard limits should be replaced.

E. Voltage Measurements. Socket voltages should be measured with the OFF-COMP.-REC.ANT.-REC.LOOP switch in REC.ANT. position and compared to the values given in the table in Section 6-3-2. If any considerable variation from typical values is noted, check all resistors, capacitors, and wiring in circuits associated with the tube elements.

F. Audio Output Amplifier Test. Plug a headset into the TEL jack on the remote control unit and while listening, touch the grid cap of the second detector tube. A loud click or whistle should be heard. If no sound is heard, measure the socket voltages of the audio output tube V11, and the second detector tube V10, and compare readings obtained with the values given in the table in Section 6-3-2. If any considerable variation from the typical values is noted, check wiring and components in the circuits associated with the tube elements. Apply a 400-cycle signal from an audio oscillator to the grid of the audio output tube (socket terminal 5); plug an output meter into TEL jack J1 and measure the audio oscillator voltage required for an output of 50 milliwatts. If the stage is functioning properly, it will be possible to obtain this output with an audio oscillator voltage of less than 1.5 volts. Likewise, an audio oscillator voltage of approximately .025 volts applied to the grid of the second detector tube V10, should give an output of 50 milliwatts. If the output is low when feeding the audio oscillator into the grid of the second detector, but normal when feeding into the grid of the audio output tube, connect the audio oscillator through a .1 Mfd capacitor to the plate of the second detector tube (socket terminal 3). If satisfactory output is obtained when the audio oscillator is connected to the grid of the audio output tube, but not when connected to the plate of the second detector tube, capacitor C16 or the relay RE2 contacts are defective.

G. AVC Circuit Tests. Extreme insensitivity of the radio compass unit may be caused by failure of C4-8, C4-9, or C4-10. One of these capacitors opening up removes the RF ground from the grid return of the associated stage. If the AVC is inoperative, check C6-1 for short circuit. A defective tube in the second detector stage may also cause ineffective AVC operation.

H. IF Amplifier Tests. Apply a 112.5 Kcs signal, 30% modulated at 400 cycles, to the grid of the IF tube and plug an output meter into the TEL jack. Measure the signal generator voltage required to produce an output of 50 milliwatts. If this stage is functioning properly, a signal generator input of less than 50,000 microvolts will be required. If more than 50,000 microvolts is necessary, adjust L12 and L13 to determine whether or not the sensitivity is due to misalignment of T14. If satisfactory alignment cannot be obtained, remove T14 and check all wiring and components. If function of this stage is normal, ground the grid of the RF oscillator tube V7, and apply a 112.5 Kcs signal, 30% modulated at 400 cycles from the signal generator to the grid of the first detector tube through a 0.5 Mfd capacitor, removing the regular grid clip, and shunt the grid of the first detector tube with a 500,000-ohm resistor. If this stage is functioning properly, an input of less than 900 microvolts will be necessary to produce an output of 50 milliwatts. If more than 900 microvolts is necessary, carefully check alignment of T13, alignment procedure for which will be found in Section 6-4-1. If satisfactory alignment and sensitivity of this stage cannot be obtained, remove T13 and check all wiring and components.

I. RF System Tests. Set the band switch on one of the bands on which trouble is encountered and set the tuning dial to the alignment frequency for that band as given in Section 6-4-3. Beginning at the grid of the first detector tube, apply a 30% modulated (400 cycles) signal from the signal generator. 900 microvolts input to this stage from the signal generator should give approximately 50 milliwatts output from the audio output amplifier. As the signal is fed successively into the grids of the second RF, first RF stages, etc., considerably less input from the signal generator should result in the same 50 milliwatts output. If a stage is reached where the signal necessary to produce 50 milliwatts output is greater than or only slightly less than it was for the preceding stage, that stage is faulty and tests outlined in the next two paragraphs should be applied, as the case might be.

J. RF Oscillator Tests. If socket voltage measurements on the first detector tube fail to reveal the source of trouble, set the band switch to one of the inoperative bands and rotate the tuning dial to the alignment frequency for that band, as given in Section 6-4 and apply a signal generator voltage of that frequency, 30% modulated at 400 cycles to the grid of the first detector tube as described in H, above. Turn AUDIO control fully clockwise. It should be possible to obtain an output of 50 milliwatts at the TEL jack for an input of less than 900 microvolts from signal generator. If these conditions can be met, the trouble is in one of the RF stages and the procedure outlined in the next paragraph should be followed. If the conditions cannot be met, check the alignment of the RF oscillator, following the procedure given in Section 6-4-2. If satisfactory alignment is not obtainable, remove the RF oscillator assembly, and check all wiring, contacts of S4, capacitors, resistors, and inductors.

K. RF Amplifier Tests. If socket voltage measurements on the first and second RF tubes fail to reveal the source of trouble, set band switch to one of the inoperative bands and rotate tuning dial to alignment frequency for that band, as given in Section 6-4, and apply a signal generator voltage of that frequency, 30% modulated at 400 cycles, to the grid cap of the second RF tube. It should be possible to obtain an output at the TEL jack of 50 milliwatts for an input of less than 120 microvolts from the signal generator. If these conditions cannot be met, check the alignment of the second RF circuit, following procedure given in Section 6-4-2. If satisfactory alignment is not obtainable, remove the second RF assembly, and check wiring, switch contacts, capacitors, and resistors. If satisfactory output is obtainable from the second RF stage, the procedure outlined above should be repeated for the first RF stage. It should be possible to obtain an output of 50 milliwatts with an input of 20 microvolts to the grid of the first RF tube. If the first RF stage is functioning properly, apply a 5-microvolt signal to the antenna pin on the panel of the compass unit, and if 50 milliwatts or more output, with no more than 12.5 MW noise, is not obtainable, check antenna relay contacts R18, C21-1, and operation of the relay. If normal operation is still unobtainable, remove the antenna shield can assembly, and check wiring, switch contacts, capacitors and antenna coils located in T4, T5, and T6.

6-3-1-4. Low REC.LOOP Output

Operate the radio compass with the OFF-COMP.-REC.ANT.-REC.LOOP switch in REC. LOOP position. Tune to stations in each band, observing whether trouble is encountered on all bands or only on one or two bands. If equipment is inoperative on all bands, proceed as outlined in paragraph A. If, however, trouble is encountered on only one or two bands, remove the compass unit from the cabinet and set up on the test bench. Measure voltage on the plates of modulator tube V3 for each setting of the band switch. If any considerable variation is noted from values given in Section 6-3-2, remove the antenna shield can assembly, and check contacts of S1-2 and plate windings of T4, T5, and T6 for open or short circuits. If the nature of the trouble encountered on only one or two bands is not apparent from the foregoing tests, proceed as outlined in paragraph B below.

A. Modulator Test. Measure socket voltages of the modulator tube and compare with values given in voltage table. If any considerable variation from typical values is noted, check wiring and components of the circuits associated with the tube elements. With the OFF-COMP.-REC.ANT.-REC.LOOP switch in COMP. position and the compass unit tuned to the aligning frequency (as given in Section 6-4) on any one of the faulty bands, set the loop gain, COMPASS, and threshold sensitivity controls at maximum and ground grid 1 (socket terminal 4) of the modulator tube. Apply a 7-microvolt signal generator voltage of the aligning frequency to grid 2 (socket terminal 5) of the modulator tube and observe the left-right compass indicator. If the modulator stage is functioning properly, the indicator pointer will deflect full scale to right. Repeat test, grounding grid 2 and applying signal to grid 1. The indicator pointer should deflect full scale to left.

B. Loop Amplifier Test. Measure the socket voltages of tube V1 and compare readings obtained with values given in the voltage table. If any considerable variations from typical values are noted, check wiring and components of circuits associated with the tube elements. If all bands are inoperative, remove the phasing can assembly and check all wiring and components for open or short circuits. If only one or two bands are inoper-

ative, roughly check alignment of loop stage trimmers of the bands at fault. If proper alignment appears impossible, remove the loop shield can assembly and check all components, switch contacts, and wiring.

C. Loop Test. Test loop, mounting (brushes and rings on rotatable mounting), and loop cable for open or short circuits or grounds. Also check for poor contact at plugs.

D. Loop Stage Alignment. If it has been necessary to make any alteration in the settings of the loop stage trimmers, it will be necessary to realign this stage completely. The procedure outlined in Section 6-4-5 should be followed.

6-3-1-5. Noisy Compass or Receiver Operation

To locate the cause of noisy operation, check the following components:

Check	*For*
Vacuum tubes	Microphonic or defective tubes.
Dynamotor	Worn or arcing brushes.
Loop	Dirty or flattened pins.
Loop mounting	Corroded sockets, dirty brushes or rings.
Cable plugs	Poor contacts.
Bonding	Loose connections. Chassis not grounded.
Switches	Dirty contacts.
Variable capacitors	Dirt between plates.
Power source	Loose or corroded connections.
Circuits	Loose wires, defective capacitors or resistors.

6-3-2. Typical MN-26A and MN-26C Vacuum Tube Socket Voltages

Battery voltage, 14 volts (28-volt operation will give similar typical voltages). Equipment operating on COMP. Threshold sensitivity, COMPASS, loop gain, and AUDIO controls all fully clockwise. Band switch on Band III. All voltages are measured to the chassis unless otherwise stated. Allowable tolerance of voltage variation ±10%. Measurements made with a 5000 ohms per volt DC voltmeter. Plate and screen voltages measured on 250-volt scale. Heater, suppressor, and cathode voltages measured on 10-volt scale unless otherwise specified.

Tube	*Socket Terminal*	*Element*	*Voltage*
V1,6K7	2 to 7	Heater	6.4
Loop Amp.	3	Plate	192.
	4	Screen	97.
	5	Suppressor	2.8
	8	Cathode	2.8
V2,6N7	2 to 7	Heater	6.5
Audio Osc.	3	Plate (P_2)	200.
	6	Plate (P_1)	200.
	8	Cathode	1.0
V3,6N7	2 to 7	Heater	6.4
Mod.	3	Plate (P_2)	170.
	6	Plate (P_1)	170.
	8	Cathode	10.
V4,6K7	2 to 7	Heater	6.6
1st RF	3	Plate	170.
	4	Screen	77.
	5	Suppressor	0.
	8	Cathode	3.0
V5,6K7	2 to 7	Heater	6.4
2nd RF	3	Plate	175.
	4	Screen	75.
	5	Suppressor	0.
	8	Cathode	3.0
V6,6L7	2 to 7	Heater	65
1st Det.	3	Plate	1900
	4	Screen	85.0
	5	Grid #3	2.8
	8	Cathode	3.8
V7,6J5	2 to 7	Heater	6.5
Het. Osc.	3	Plate	62.
	8	Cathode	0.
V8,6K7	2 to 7	Heater	6.3
IF Amp.	3	Plate	167.
	4	Screen	125.
	5	Suppressor	0.
	8	Cathode	4.7
V9,6J5	2 to 7	Heater	6.5
CW Osc.	3	Plate	*23.
V10,6B8	2 to 7	Heater	6.6
2nd Det.	3	Plate	75.
	6	Screen	75.
	8	Cathode	**15.
V11,6F6	2 to 7	Heater	6.6
Audio Amp.	3	Plate	195.
	4	Screen	210.
	8	Cathode	**13.
V12,6K7	2 to 7	Heater	6.4
Comp. Amp.	3	Plate	195.
	4	Screen	65.
	5	Suppressor	0.
	8	Cathode	1.4

NOTES: * CW On
** 50V Scale

When vacuum tube socket voltages are found to vary appreciably from the typical values given in the above table, the trouble can usually be located as described below:

A. Heater Voltage High: Heater burned out in one of the tubes in the same parallel connected group. See Figure 9.

B. Heater Voltage Low: Dirty contacts on S8. Heater burned out in one of the tubes in the other parallel connected group.

C. Plate Voltage High: Shorted plate resistor. Open screen or cathode circuit.

D. Plate Voltage Low: Ground on plate lead. Defective screen or cathode bypass capacitor. Defective plate coupling capacitor.

E. Screen Voltage Low: Defective screen or cathode bypass capacitor.

F. Cathode Voltage High: Open cathode resistor. R2 open. L2 or L3 open.

G. Cathode Voltage Low: Defective cathode bypass capacitor or resistor.

6-4. RADIO COMPASS UNIT ALIGNMENT

This equipment has been carefully adjusted and aligned by the manufacturer and thoroughly inspected before shipment. The circuits are designed so that their alignment will be maintained over long periods of time. Before changing any adjustments it must be ascertained that the difficulty is not the result of normal deteriorating influences such as worn out vacuum tubes, blown fuses, improper operating voltages, broken cords, external RF interference, etc. FACTORY ADJUSTMENTS ARE SEALED WITH PURPLE GLYPTAL AND ARE NOT TO BE ALTERED UNLESS ABSOLUTELY NECESSARY. Any questionable performance characteristics should be measured in accordance with Section 6-5 before and after adjustment. All aligning adjustments are accessible from the top of chassis (see Figure 2) and are:

Band	*Aligning Freq.*	*Loop*	*Antenna*	*Radio Freq-1*	*Radio Freq-2*	*RF Osc*
I—(150- 325 Kcs)	325 Kcs	C1-1	C1-4	C1-7	C1-10	C1-13
II—(325- 695 Kcs)	695 Kcs	C1-2	C1-5	C1-8	C1-11	C1-14
III—(695-1500 Kcs)	1500 Kcs	C1-3	C1-6	C1-9	C1-12	C1-15

6-4-1. Intermediate Frequency Amplifier Alignment

6-4-1-1. Second IF Stage Alignment

Operate on REC.ANT. and plug a 600- or 4000-ohm output meter, as needed, in J1 with other jack open. Set AUDIO on maximum. Set tuning dial to 695 Kcs on Band II.

Apply a 112.5 Kcs signal, 30% modulated at 400 cycles, directly to the grid of the IF tube, leaving the regular grid clip in place. The signal generator output should be adjusted to about 100,000 microvolts.

Adjust L12 and L13 of T14 for maximum output, reducing the signal generator voltage as necessary to keep the output of the radio compass unit at approximately 50 milliwatts. The input to V8 when T14 is properly aligned should be between 25,000 and 40,000 microvolts.

While the signal generator is at exactly 112.5 Kcs, turn off modulation and turn CW switch ON. Adjust coil L6 for zero beat. The CW oscillator will then oscillate at the IF frequency and the zero beat method of aligning the RF oscillator stage may be employed. After completion of alignment, the CW oscillator should be readjusted to 113.5 Kcs for the 1000-cycle per second difference frequency.

6-4-1-2. First IF Stage Alignment

With the dial still turned to 695 Kcs on Band II, AUDIO control turned fully clockwise, and OFF-COMP.-REC.ANT.-REC.LOOP switch on REC.ANT. position, attach the lead from the signal generator to the grid of the first detector tube through a 0.5 Mfd capacitor, removing the regular grid clip, and shunt the grid of the first detector tube with a 500,000-ohm resistor. Ground the grid of the heterodyne oscillator V7. Adjust the signal generator to 114.5 Kcs, 30% modulated at 400 cycles and an output of 1000 microvolts. Adjust L10 and L11 for maximum output. Reset the signal generator to a frequency of 110.5 Kcs and readjust L10 and L11 for maximum output. Reset the signal generator to 114.5 Kcs and readjust L10 and L11 for maximum output. This completes the alignment of this stage.

Set the signal generator at 112.5 Kcs and check the input to V6 required for a 50-milliwatt output. This input should be approximately 900 microvolts. See Section 6-4-6 for CW oscillator alignment.

6-4-2. RF Oscillator Alignment

Operate radio compass unit on REC.ANT. switch position; AUDIO control at maximum clockwise position, plug headset into J1, and couple the signal generator to the control grid of the first detector tube.

Turn on CW oscillator, which has previously been adjusted to 112.5 Kcs.

Set the signal generator to 1500 Kcs 1000 microvolts output, unmodulated. Rotate the tuning dial to 1500 Kcs on Band III and rotate trimmer C1-15 for zero beat in headphones.

Set the generator to 695 Kcs and the tuning dial to 695 Kcs on Band II. Adjust trimmer C1-14 for zero beat.

Set the generator to 325 Kcs and the tuning dial to 325 Kcs on Band I. Adjust trimmer C1-13 for zero beat.

NOTE: If subsequent sensitivity measurements indicate poor tracking at the low frequency ends of any of the bands, adjustment of the oscillator coil inductance on one or more bands will be necessary. The same equipment setup and procedure used at the high frequency ends of the bands is used for this alignment which is accomplished by adjusting the settings of the iron core screws (glyptalled factory adjustments) in T10, T11, or T12 (Bands I, II, and III oscillator transformers, respectively) as the case may be. If any alteration of the oscillator coil inductance is made, it is necessary to repeat the oscillator alignment procedure at the high frequency ends of the band or bands in question, as outlined above.

6-4-3. First and Second RF Amplifier and Antenna Stage Alignment

Operate the compass unit on REC.ANT. switch position, AUDIO control at maximum clockwise position, plug an output meter into J1 and connect a signal generator to the antenna plug through a 100 Mmf, dummy antenna. Set the signal generator for 30% modulation at 400 cycles.

Band III Alignment. Set tuning dial to 1500 Kcs on Band III, and adjust signal generator to 1500 Kcs and whatever output is necessary to produce less than 50 milliwatts output. Adjust trimmers C1-12, C1-9, and C1-6 for maximum output, reducing the input from the signal generator as much as is necessary to keep output at approximately 50 milliwatts. Set signal generator output at 10 microvolts and reduce AUDIO control setting to the point at which slightly less than 50 milliwatts output is obtained and touch up trimmers C1-12, C1-9, and C1-6 for maximum output.

Band II Alignment. Set tuning dial to 695 Kcs on Band II, reset AUDIO control to maximum clockwise setting, and adjust signal generator to 695 Kcs and whatever output is necessary to produce less than 50 milliwatts output. Adjust trimmers C1-11, C1-8, and C1-5 for maximum output. Set signal generator output at 10 microvolts and reduce AUDIO control setting to the point at which slightly less than 50 milliwatts output is obtained and touch up trimmers C1-11, C1-8 and C1-5 for maximum output.

Band I Alignment. Set tuning dial to 325 Kcs on Band I, reset AUDIO control to maximum clockwise setting, and adjust signal generator to 325 Kcs and whatever output is necessary to produce less than 50 milliwatts output. Adjust trimmers C1-10, C1-7, and C1-4 for maximum output. Set signal generator output at 10 microvolts and reduce AUDIO control setting to the point at which slightly less than 50 milliwatts output is obtained and touch up trimmers C1-10, C1-7, and C1-4 for maximum output.

6-4-4. Adjustment of the IF Rejection Traps

Connect signal generator to the compass unit antenna plug through a 100 Mmf capacitor, set tuning dial to 150 Kcs on Band I, and adjust the signal generator to 4 microvolts output at 150 Kcs 30% modulation at 400 cycles. Adjust AUDIO control to the point at which 50 milliwatts output is obtained.

Set the signal generator to 114.5 Kcs and adjust the input to one volt. Leaving the generators set, adjust the iron core of L3 until minimum output is obtained. Readjust the signal generator frequency to 110.5 Kcs and adjust the iron core of L2 for minimum output. With these adjustments made as described, there should not be over 30 milliwatts of power output with one volt of input.

6-4-5. Loop Alignment

Set the equipment as for a standard radio compass test setup. Turn the loop parallel to the transmission line and set the OFF-COMP.-REC. ANT.-REC.LOOP switch to REC.LOOP position.

Tune compass unit to 1500 Kcs on Band III and adjust signal generator to the same frequency and for an input to the loop of approximately 100 microvolts per meter, 30% modulated at 400 cycles. Adjust C1-3 for maximum indication on the output meter, adjusting AUDIO control knob to maintain output meter reading below 50 milliwatts.

Switch to Band II and set tuning dial at 695 Kcs. Adjust the signal generator to the same frequency and an input to the loop of approximately 100 microvolts per meter. Adjust C1-2 for maximum indication on output meter, adjusting AUDIO control knob to maintain output meter reading below 50 milliwatts.

Switch to Band I and set tuning dial to 325 Kcs. Adjust signal generator to the same frequency and an input to the loop of approximately 100 microvolts per meter. Adjust C1-1 for maximum indication on the output meter, adjusting AUDIO control knob to maintain output meter reading below 50 milliwatts.

If loop sensitivity is unsatisfactory at the low frequency end of any band or bands, it will be necessary to readjust the inductance of loop coils, T1, T2, and T3. This may be accomplished by repeating the procedure outlined in the three above paragraphs, adjusting the iron cores, which have been glyptalled in place at the factory, for maximum indication on an output meter. These adjustments should be made at the low frequency ends of the three bands (695 Kcs, 325 Kcs, and 150 Kcs). If it is necessary to change the settings of any of these core adjustments, it will be very important to readjust the loop trimmers C1-1, C1-2, and C1-3 as outlined above.

6-4-6. CW Oscillator Alignment

Operate on REC.ANT., plug a headset into the TEL jack J1. Set tuning dial to 695 Kcs on Band II. Attach the lead from signal generator to grid of the first detector tube through a 0.5 Mfd capacitor, removing the regular grid clip, and shunt the grid of the first detector tube with a 500,000-ohm resistor.

Apply a 113.5 Kcs signal unmodulated. The signal generator output should be approximately 1500 microvolts.

Adjust CW oscillator coil L6 for zero beat as heard in the headphones.

6-5. OVERALL PERFORMANCE CHARACTERISTICS

6-5-1. General

If at any time operation of the equipment is questionable, the performance of the equipment should be measured in accordance with the following typical procedures and values. After making any major repairs or adjustments, performance should be measured to insure that the adjustments have been properly made.

6-5-2. Standard Test Conditions

For these tests the following conditions should be maintained unless otherwise stated:

Signal-to-noise ratio of 4 to 1 in power, 2 to 1 in voltage. The noise output is 12.5 milliwatts when standard output is 50 milliwatts or 7 volts when standard output is 14.1 volts.

Standard Output. 50 milliwatts or 14.1 volts (signal and noise). This output may be obtained from either of the remote control unit jacks with plug out of the other jack. On receiver operation adjust AUDIO control for standard signal-to-noise ratio. On COMP. adjust AUDIO control for maximum output.

Artificial Antenna. Receiver 100 Mmf, compass 100 Mmf, and one-half meter effective height.

Standard Modulated Signal 30% 400 cycles per second.

Warm up period—20 minutes.

Low voltage supply +14 or +28 volts.

6-5-3. Sensitivity: REC.ANT.

Apply the standard modulated signal to the antenna terminal through an artificial antenna. Set generator output at approximately 5 microvolts. Carefully tune the radio compass unit to resonance. Cut off modulation, leaving the carrier on. Set AUDIO control to obtain 12.5 milliwatts average noise output. Turn modulation on and set generator output to the value which gives 50 milliwatts receiver output. Turn off modulation and reset AUDIO control to obtain 12.5 milliwatts average noise output. Repeat until 50 milliwatts output is obtained with modulation on and 12.5 milliwatts noise with modulation off. Repeat above procedure for each test frequency. Record receiver input on a form similar to that contained in Section 6-5-12.

6-5-4. Minimum Noise Level

Minimum noise level can be measured by operating on REC.ANT. and turning AUDIO control to minimum. Output levels greater than 0.050 milliwatts indicate trouble in dynamotor, filtering, or second detector and audio circuits.

6-5-5. Intermediate Frequency Rejection Ratio

Measure REC.ANT. sensitivity at test frequency (150 Kcs). Set signal generator at point of greatest response near 112.5 Kcs and increase its output until 50 milliwatts receiver output is obtained. The ratio of the attenuator setting at 112.5 Kcs and at the test frequency is the rejection ratio. Record this data on a form similar to that contained in Section 6-5-12. NOTE: The harmonics of the signal will appear in the frequency range of the equipment (i.e. 225, 337.5, etc.) To avoid response from harmonics select a test frequency half way between these harmonics.

6-5-6. Image Rejection Ratio

Measure REC.ANT. sensitivity of equipment first at test frequency (1500 Kcs) and again with signal generator set 225 Kcs above the test frequency. Do not disturb tuning of equipment but vary the signal generator frequency slightly until maximum response is obtained. The ratio of the signal generator output of the two settings is the image rejection ratio. Record this data on a form similar to that in Section 6-5-12.

6-5-7. AVC Action

Operate on REC.ANT., audio control maximum. Apply a standard modulated signal to the antenna terminal through a 100 Mmf artificial antenna. Record milliwatts output against microvolts input on a form similar to that of Section 6-5-12. The test frequency generally used is 655 Kcs.

6-5-8. Selectivity: REC.ANT.

Measure REC.ANT. sensitivity of equipment at the high frequency end of each band. Increase the signal generator attenuator setting so that the output is 1000 times that of the measured sensitivity. Vary signal generator frequency above and below resonance until output equals original test output. Record the band width on a form similar to that of Section 6-5-12.

6-5-9. Sensitivity: REC.LOOP

Mount loop beneath the reference transmission line. Operate on REC.LOOP. Turn loop for maximum pick-up. Adjust AUDIO control for a signal to noise power ratio of 4 to 1 as done for REC.ANT. sensitivity measurement of Section 6-5-3. Record microvolts per meter field strength at the center of the loop for standard receiver output on a form similar to Section 6-5-12.

6-5-10. Compass Sensitivity Uniformity and Accuracy

Mount the loop beneath the reference transmission line. Operate on COMP. Use a 100 Mmf, 0.5 meter artificial antenna. Adjust COMPASS control so that approximately 5 to 6 degrees rotation of the loop produces full scale indicator deflection, with an input of 1000-μV/M (800 Kcs) at the center of the loop. Without changing COMPASS control setting, record the degrees rotation of loop required to produce zero and full-scale right and left indicator pointer deflection, for 50, 100, and 100,000 microvolts per meter input at different test frequencies on a form similiar to that of Section 6-5-12.

6-5-11. Input for Full Scale Indicator Deflection

This test requires a well shielded compass test room. Mount loop beneath the reference transmission line. COMPASS control on maximum. Apply an 800 Kcs signal of 1000 microvolts per meter field strength at the center of the loop.

Record number of degrees loop rotation required for left and right full scale indicator deflection. Typical loop settings are 5.5 degrees left for full scale left deflection, 0 for on-course setting, and 5.5 degrees right for full scale right deflection.

6-5-12. Typical Performance Data

The following performance characteristics are the average of a number of production tests. Any equipment whose performance approximates that of the figures given below is considered satisfactory.

Para. No.	Test Point			1-L	1-M	1-H	2-L	2-M	2-H	3-L	3-M	3-H
	Test Freq (Kcs)			150	220	325	325	470	695	695	1100	1500
6-5-3	REC.ANT. Sens. μV			4.1	3.2	2.6	3.2	3.2	2.8	4.0	3.5	3.2
6-5-5	I F Rej. Ratio			300M/1	..	..	..	..	..	..	..	..
6-5-6	Image Rej. Ratio			..	..	..	..	..	..	..	..	22000/1
6-5-9	Loop Sens. μV/M			77.4	58.5	54.8	63.4	49.4	37.4	49.8	36.8	29.4
6-5-10	Compass Sensitivity Uniformity and Accuracy	50 μV/M	O	+.2	−.2	O	+.2	O	−.1	O	O	O
			R	14.	13.2	16.8	18.8	15.2	19.	20.2	15.9	17.
			L	13.5	13.7	16.7	17.5	15.2	19.3	20.2	15.8	17.
		100 μV/M	O	−.8	O	O	O	O	−.5	O	O	−.2
			R	10.4	12.	15.1	16.5	14.8	18.	15.9	15.	14.8
			L	12.	12.1	15.4	16.7	14.8	19.	15.8	15.	15.2
		100,000 μV/M	O	+.2	−.1	+.1	O	O	−.1	O	O	−.2
			R	11.5	11.2	14.8	16.4	15.	18.	16.1	15.	15.6
			L	11.	11.5	14.5	16.6	15.2	18.2	16.	15.2	16.
6-5-8	REC.ANT. Selectivity Res. Input Band Width X 1000			..	..	11.4	..	..	13.4	..	..	15.5
6-5-11	Loop Rotation for Full Scale Indicator Deflection at 800 Kcs			1000 μV/M			L=5.5°,			R=5.5°		
6-5-7	AVC Action Mod. 30% Test Freq. 655 Kcs			Input		5 μV			100 μV			1V
				Mw Output		55			650			1550

Symbol	Function	Description	Bendix No.
		NEON TUBES	
NE1	Overload discharge	1/25 W, 60V AC, Unbased neon tube	QB15347
NE2	Overload discharge	Same as NE1	..
		RESISTORS	
R1	Loop Gain Control	15,000Ω, Pot, D taper	QB15353
R7	V1 Cathode Bias	300Ω, ±10%, ¼W, Ceramic	A18151-301
R9-1	V1 RF Compensator, Band 3	Each, 3Ω, ±10%, ½W, WW	A16428-3
R9-2	V5 RF Compensator, Band 3		
R9-3	V6 RF Compensator, Band 3		
R10-1	V5 RF Compensator, Band 2	10Ω, ±5%, ½W, WW	A16428-2
R10-2	V6 RF Compensator Band 2	Same as R10-1	..
R11-1	V5 RF Compensator Band 1	20Ω, ±5%, ½W, WW	A16428-4
R11-2	V6 RF Compensator, Band 1	Same as R11-1	..
R12-2	V4 Screen Voltage Dropping	Each, 100,000Ω, ±10%, ¼W, Ceramic	A18151-104
R12-3	V5 Screen Voltage Dropping		
R12-4	V10 Grid		
R12-5	V8 AVC Filter		
R12-6	V3 Audio Voltage Supply		
R12-7	V3 Audio Voltage Supply		
R12-8	AVC Filter		
R12-9	Sidetone Filter		
R12-10	V2 Audio Voltage Filter		
R12-11	V2 Audio Voltage Filter		
R12-12	V3 Cathode Bias		
R12-13	V3 Plate Dropping		
R12-14	V9 Grid Leak		
R12-15	V9 Plate Voltage Dropping		
R13-1	V6 Screen Voltage Bleeder	150,000Ω, ±10%, ¼W, Ceramic	A18151-154
R13-2	V12 Screen Voltage Dropping	Same as R13-1	..
R14-1	V2 Grid Leak	Each, 50,000Ω, ±10%, ¼W, Ceramic	A18151-503
R14-2	V2 Grid Leak		
R14-3	V6 Injector Grid Leak		
R14-4	V7 Grid Leak		
R14-5	V10 RF Filter		
R14-6	V3 Cathode Bias		
R14-7	V4 AVC Filter		
R14-8	V5 AVC Filter		
R14-9	V6 AVC Filter		
R14-10	V8 Screen Voltage Dropping		
R14-11	V7 Plate Voltage Dropping		
R14-12	V9 Grid Return		
R14-13	V1 Screen Voltage Dropping		
R15-1	V2 Plate Load	2000Ω, ±10%, ¼W, Ceramic	A18151-202
R15-2	V2 Plate Load	Same as R15-1	..
R18	Ant. Static Leak	1,000,000Ω, ±10%, ¼W, Ceramic	A18151-105
R19-1	V12 Grid Resistor	1000Ω, ±10%, ¼W, Ceramic	A18151-102
R19-2	V1 Plate Voltage Dropping	Same as R19-1	..
R20-2	V4 Plate Voltage Dropping	Each, 5,000Ω, ±10%, ¼W, Ceramic	A18151-502
R20-3	V5 Plate Voltage Dropping		
R20-4	V6 Plate Voltage Dropping		
R20-5	V8 Plate Voltage Dropping		
R21	V3 Cathode Bleeder	200,000Ω, ±10%, ¼W, Ceramic	A18151-204
R22-1	V3 Grid Load	Each, 500,000Ω, ±10%, ¼W, Ceramic	A18151-504
R22-2	V3 Grid Load		
R22-3	V12 Grid		
R22-4	V10 AVC Diode Load		
R22-5	V11 Grid		
R23	V3 Cathode Bias	10,000Ω, ±10%, ¼W, Ceramic	A18151-103
R24-1	V4 Cathode Bias	Each, 600Ω, ±10%, ¼W, Ceramic	A18151-601
R24-2	V5 Cathode Bias		
R24-3	V6 Cathode Bias		
R24-4	V8 Cathode Bias		
R24-5	V12 Cathode Bias		
R27	V2 Cathode Bias	100Ω, ±10%, ¼W, Ceramic	A18151-101
R28	V10 Grid Load	250,000Ω, ±10%, ¼W, Ceramic	A18151-254
R29	V11 Cathode Bias	500Ω, ±10%, ½W, Ceramic	A18150-501
R31	V10 Cathode Bias	3,000Ω, ±10%, ¼W, Ceramic	A18151-302
R32	V12 Grid Isolating	300,000Ω, ±10%, ¼W, Ceramic	A18151-304
R35-1	Azimuth Dial Light Dropping	117Ω Total, Sect A 50Ω, Sect B 67Ω	A14739
R36	Ant. Relay Voltage Dropping	195Ω Total, Sect A 120Ω, Sect B 75Ω	A30031
R37-1	Fil. Current Compensating	75.6Ω Total, Sect A 12.6Ω, Sect B 63Ω	A15273
R37-2	Sidetone Relay Dropping	Same as R37-1	..
R38	V10 Plate Voltage Dropping	25,000Ω, ±10%, ¼W, Ceramic	A18151-253
R39	V6 Screen Voltage Supply	25,000Ω, ±10%, ½W, Ceramic	A18150-253
		RELAYS	
RE1	Antenna	DPDT, 8-16 Volts	QB7856
RE2	Sidetone	Same as RE1	..

Symbol	Function	Description	Bendix No.
		SWITCHES	
S1-1 S1-2 S1-3 S1-4	Loop, Band Selector, Pri. Antenna, Band Selector, Pri. 1 1st RF, Band Selector, Pri. Sec. 2nd RF, Band Selector, Pri. Sec.	Each, Bakelite, Wafer	QB9589-2
S2	Loop, Band Selector, Sec.	Bakelite, Wafer	QB9589-1
S3	Antenna, Band Selector Pri. and Sec.	Bakelite, Wafer	QB9589-4
S4	HF Osc, Band Selector	Bakelite, Wafer	QB9589-3
S5	Motor Positioning	Bakelite, Wafer	QB9589-5
S6	Motor Control	1 make and 2 break, Non-locking	E10355
		TRANSFORMERS	
T1	Loop, Band 1	2 coils, Sealed	AL71791-1
T2	Loop, Band 2	2 coils, Sealed	AL71791-2
T3	Loop, Band 3	2 coils, Sealed	AL71791-3
T4	Antenna, Band 1	3 coils, Sealed	AL71791-13
T5	Antenna, Band 2	3 coils, Sealed	AL71791-14
T6	Antenna, Band 3	3 coils, Sealed	AL71791-15
T7-1	1st RF, Band 1	2 coils, Sealed	AL71791-7
T7-2	2nd RF, Band 1	Same as T7-1	..
T8-1	1st RF, Band 2	2 coils, Sealed	AL71791-8
T8-2	2nd RF, Band 2	Same as T8-1	..
T9-1	1st RF, Band 3	2 coils, Sealed	AL71791-9
T9-2	2nd RF, Band 3	Same as T9-1	..
T10	HF Osc, Band 1	2 coils, Sealed	AL71791-4
T11	HF Osc, Band 2	2 coils, Sealed	AL71791-5
T12	HF Osc, Band 3	2 coils, Sealed	AL71791-6
T13	1st IF Trans.	Complete assembly	AL71798-1
T14	2nd IF Trans.	Complete assembly	AL71908-1
T15	Audio Output, Ass'y contains L9-1 and T15	Pri: 645Ω, Sec: 310Ω	A14987
T16	Compass Output, Ass'y L9-2 and T16	Pri: 2400Ω, Sec: 14.5Ω	A15064
		VACUUM TUBES	
V1	Loop Amplifier	Triple grid	..
V2	Audio Oscillator	Twin triode	..
V3	Modulator	Same as V2	..
V4	1st RF	Same as V1	..
V5	2nd RF	Same as V1	..
V6	1st Detector	Pentagrid converter	..
V7	HF Oscilltaor	Triode	..
V8	IF	Same as V1	..
V9	CW Oscillator	Same as V7	..
V10	2nd Det. and 1st Audio	Duplex diode pentode	..
V11	Audio Output	Pentode power amp.	..
V12	Compass Output	Same as V1	..

7-2. TYPE MN-26C RADIO COMPASS

The MN-26C Radio Compass uses the same parts as an MN-26A except for the following:

		DYNAMOTOR	
DYN	Dynamotor	28V, 1.6A input; 230V, 100MA output	C56728-2
		MOTOR	
MO	Band Switch Motor	24-28V DC, 1.25A no load	E11500-1

7-3. TYPE MN-28A AND MN-28C REMOTE CONTROL

		FUSE	
FU1	Fuse for both 12-14V and 24-28V 10A, 25V, Littelfuse		A11302-28
		JACKS AND RECEPTACLE	
J1	Phone Jack	For headset, 1 break circuit	A28960
J2	Phone Jack	Same as J1	..
J3	Wall Mtg. Recep. for P3	16-contact	A30089
		LAMP	
LM-1	Dial Light	3V, 0.19 A	A18881-1
		PLUG	
P3	Remote to Junction Box	16-contact, Straight, Female	A30090

Symbol	Function	Description		Bendix No.
		RESISTORS		
R2	Threshold Sensitivity Control	2,000Ω, Pot., Rear, Taper D		A14551
R3	Compass Sensitivity Control	50,000Ω, Pot., Front, Taper C		
R4A	Audio Volume Control	2,000Ω, Front, Taper Special	MN-28A	L72704-1
R4B	Manual Sensitivity Control	25,000Ω, Rear, Taper Special		
R4A	Audio Volume Control	25,000Ω, Front, Taper C	MN-28C	A14550
R4B	Manual Sensitivity Control	25,000Ω, Rear, Taper E		
R6	Panel Lamp Rheostat	100Ω, Taper A		A14549
R35-3	Panel Lamp Voltage Dropping	117Ω, Total; Sect A, 50Ω; Sect B, 67Ω		A14739
		SWITCHES		
S8	Off-Comp.-Rec. Ant.-Rec. Loop	Bakelite, Wafer		A14657
S9	Band Selector	Bakelite, Wafer		QB6707
S10	CW	SPST, Toggle, 250V, 3A		A26947-1

7-4. TYPE MN-20A AND MN-24A ROTATABLE LOOPS

		RECEPTACLE	
J8	Receptacle for P8	6-contact, Wall mounting	A25200
		MISCELLANEOUS	
..	Brush Holder Assembly	..	A14692-1

7-5. TYPE IN-4A LEFT-RIGHT INDICATOR

		RECEPTACLES	
J5	Receptacle for P5	6-contact	A30094
J6	Receptacle for P6	Same as J5	..
		PLUGS	
P5	Indicator to Junction Box	6-contact, Straight, Female	A30088
P6	Indicator to Junction Box	Same as P5	..
		MISCELLANEOUS	
...	Meter Field Load Ass'y	See Section 1-2	AA18824-1

7-6. TYPE MN-22A AZIMUTH CONTROL

		RECEPTACLE	
J1	Lamp Plug Socket	Single-contact	A30273
		LAMP	
LM-3	Dial Light	3V, 0.19A	A18881-1
LM-4	Dial Light	Same as LM-3	
		PLUG	
P1	Lamp Plug	Single-contact	AB9487
		RESISTOR	
..	Lamp Series	14V: 116Ω, CT	A100199-1
		28V: 264Ω, CT	A100199-2
		CAM BLANK	
N5	Quadrantal Corrector	..	A30243

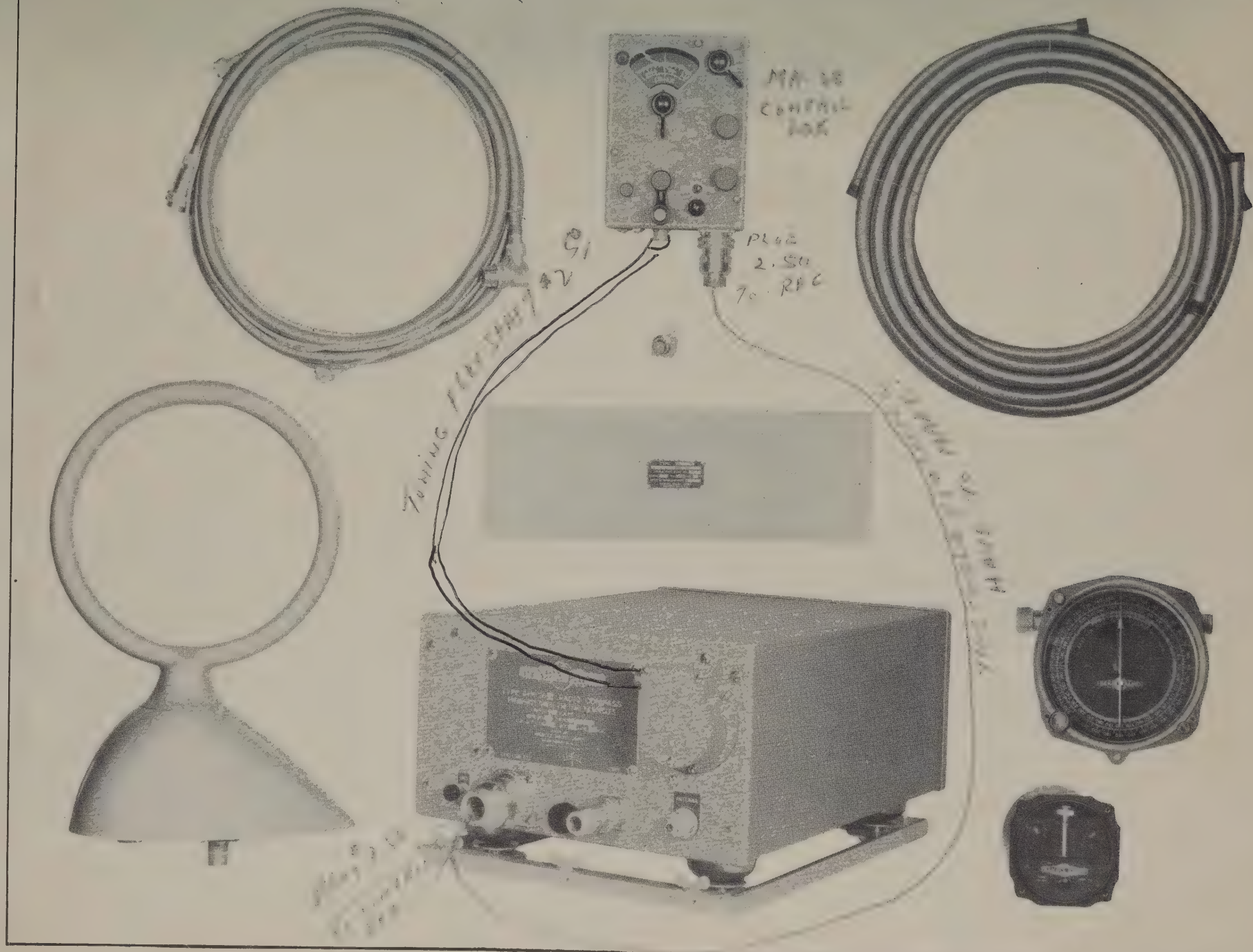


FIG. 1 - COMPOSITE VIEW MN-26A OR MN-26C EQUIPMENT

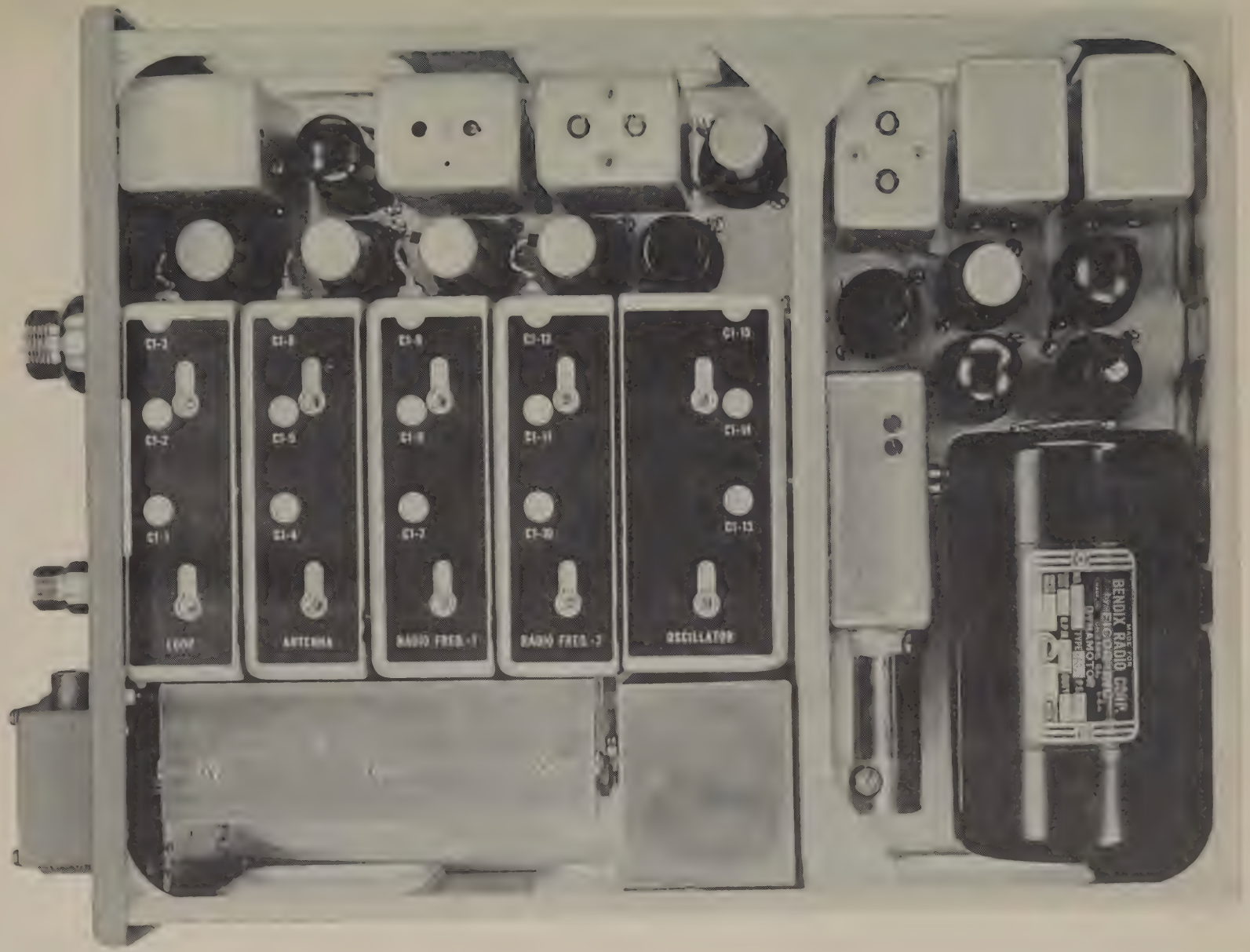


FIG. 2 - TOP VIEW, MN-26A RADIO COMPASS

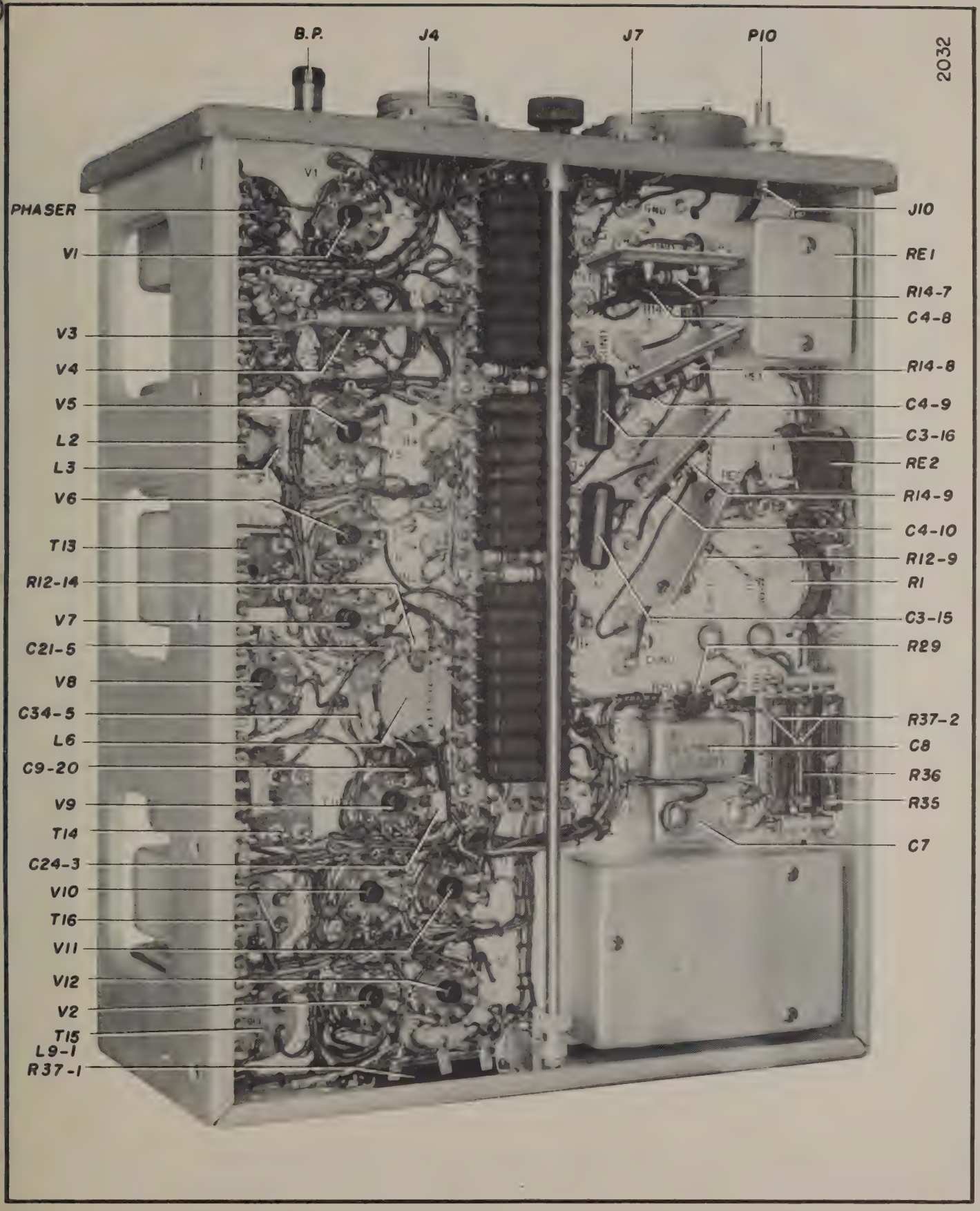


FIG. 3 - BOTTOM VIEW, MN-26A RADIO COMPASS

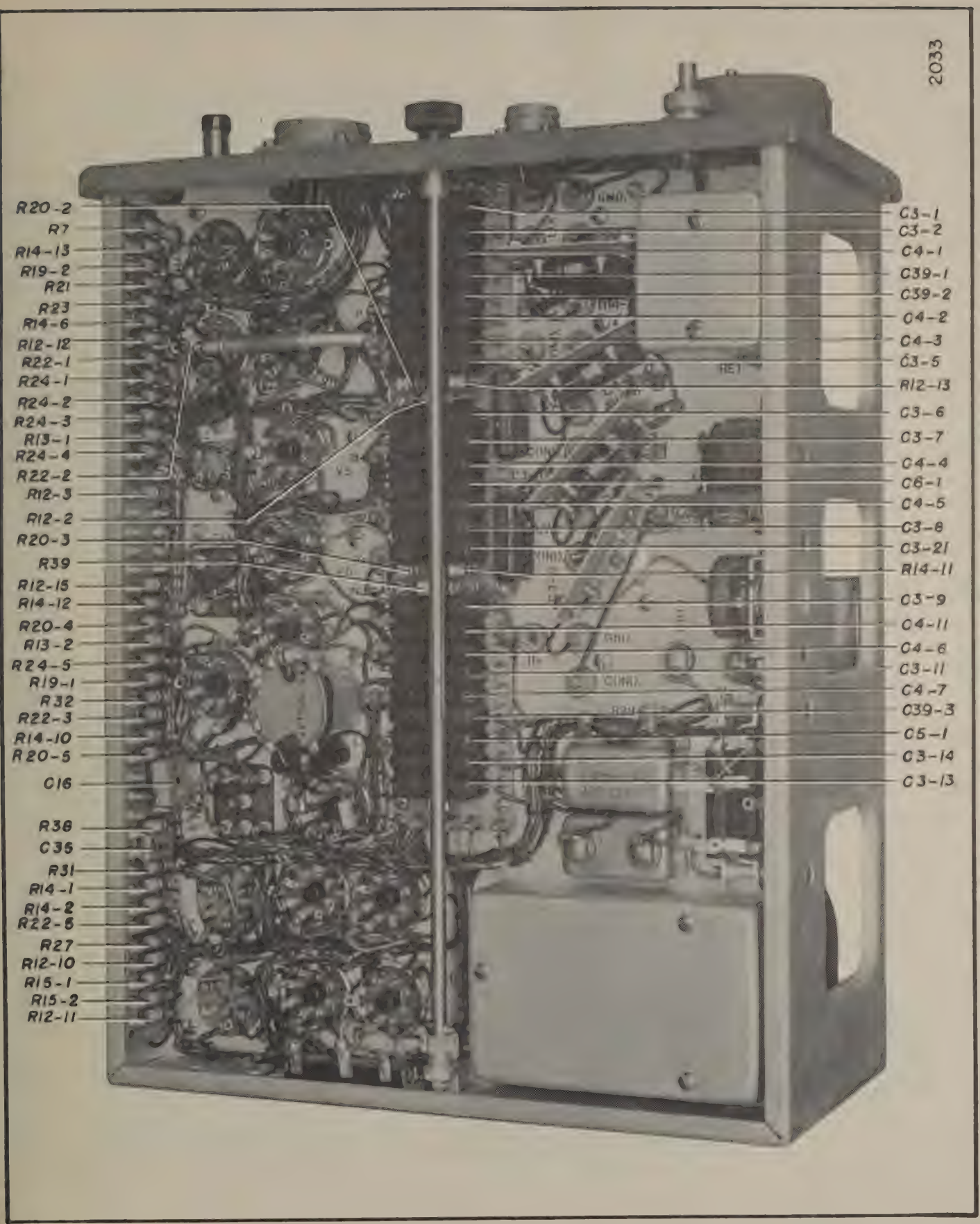


FIG. 4-BOTTOM VIEW, MN-26A RADIO COMPASS

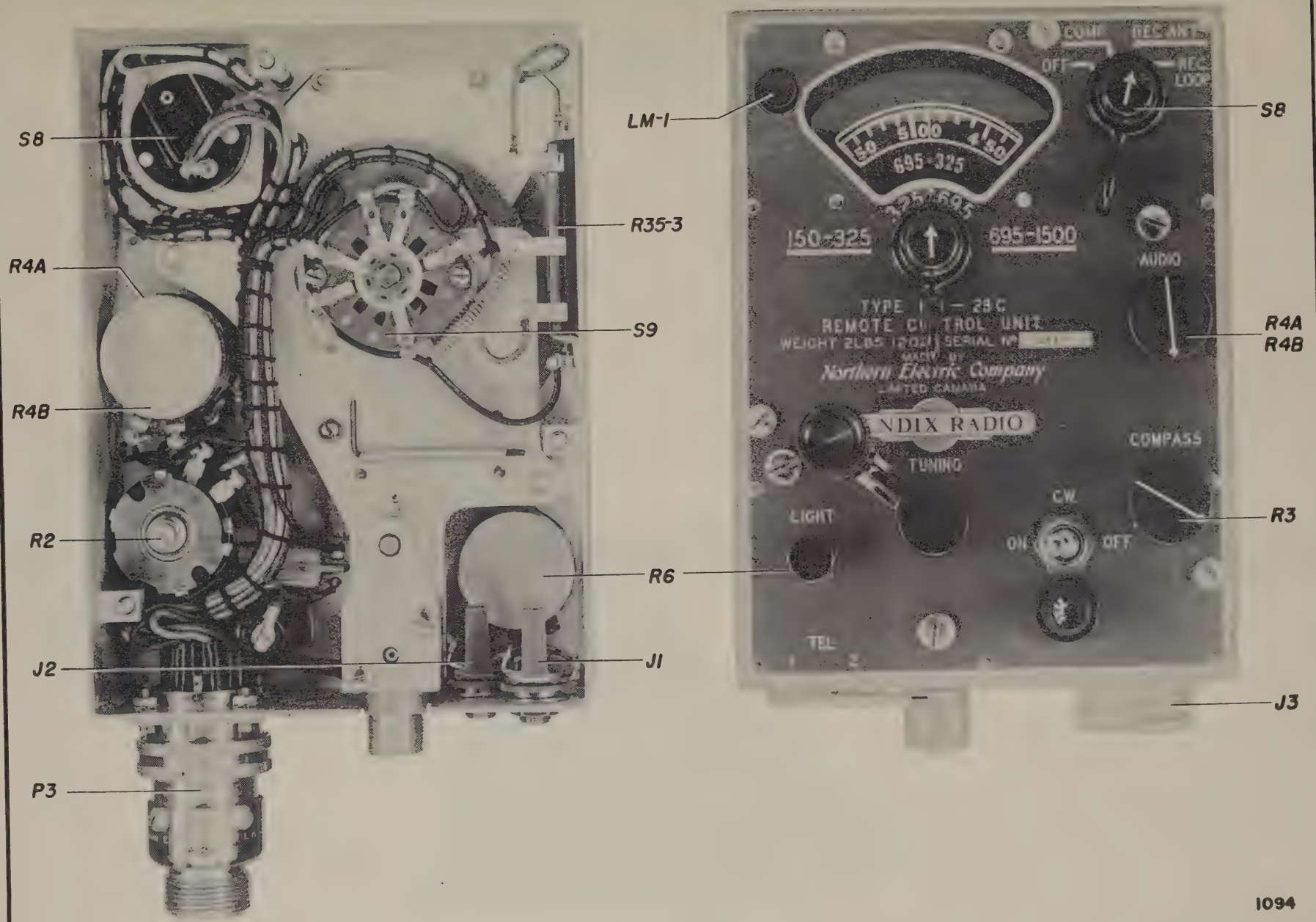


FIG. 5 - MN-28 REMOTE CONTROL UNIT

FIG. 7
MN-20 A
ROTATABLE LOOP

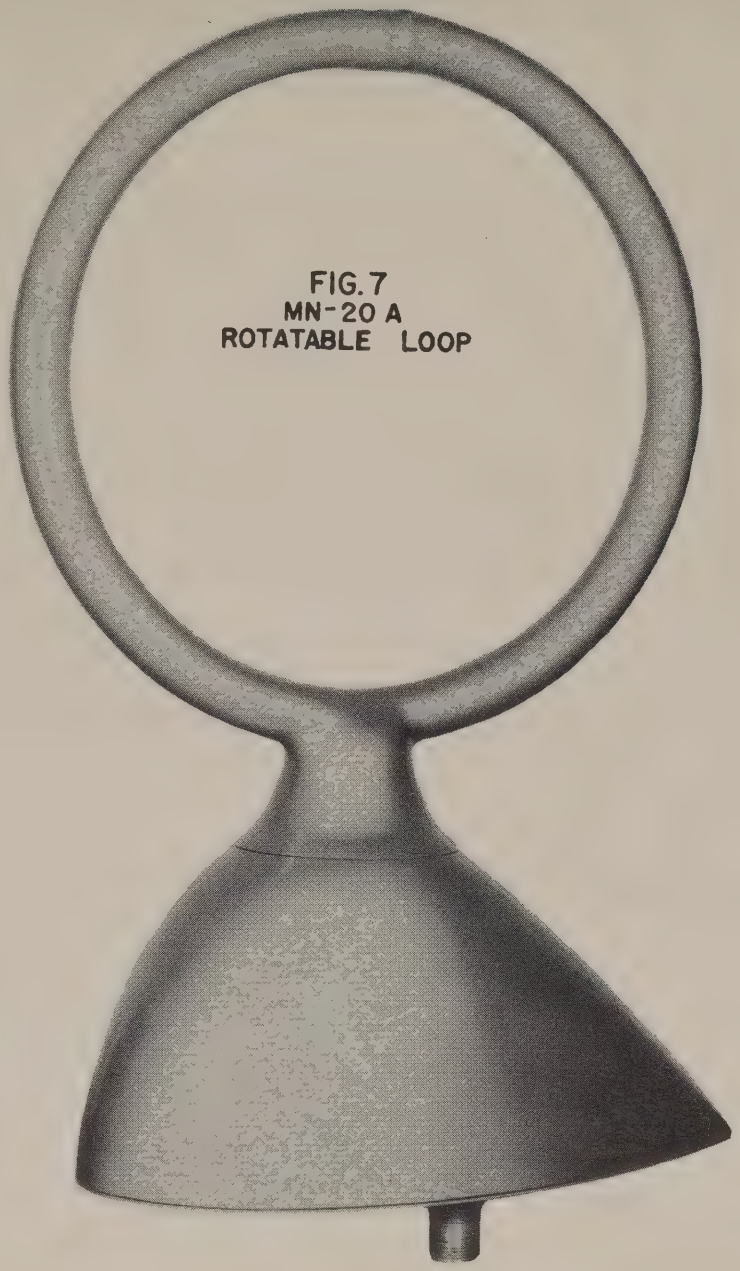
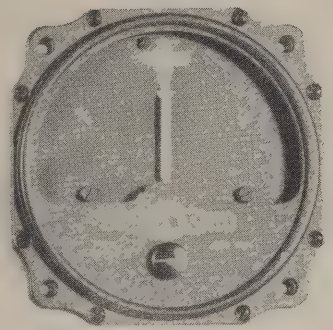
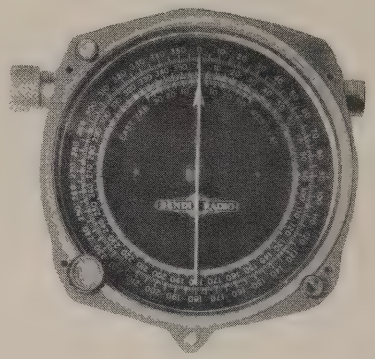


FIG 8



IN-4A LEFT-RIGHT
INDICATOR

FIG. 6



MN-22A
AZIMUTH CONTROL

1083 & 1091

FIGS. 6,7,8 - DETAILED VIEWS

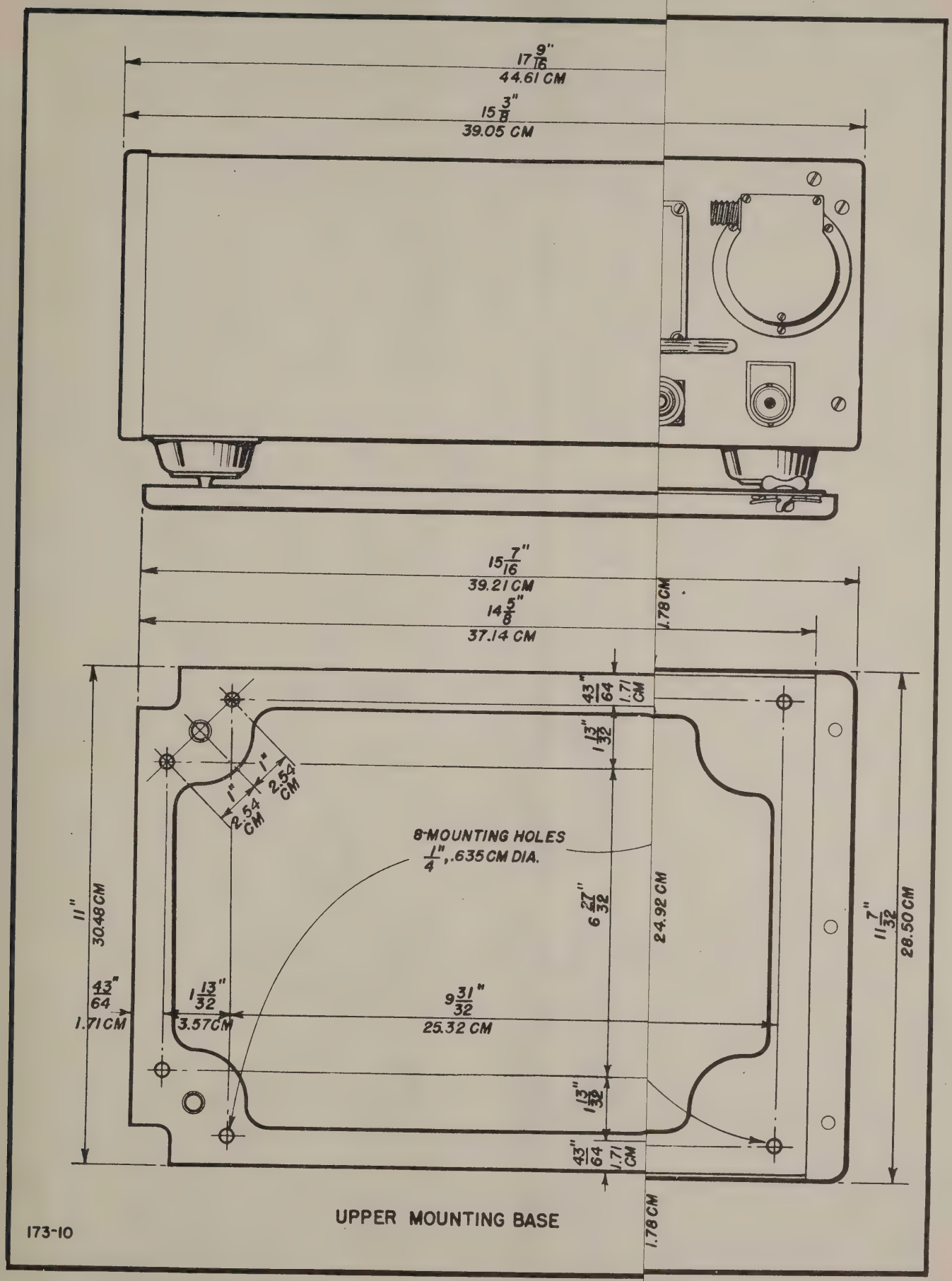


FIG. 10 - OUTLINE DI

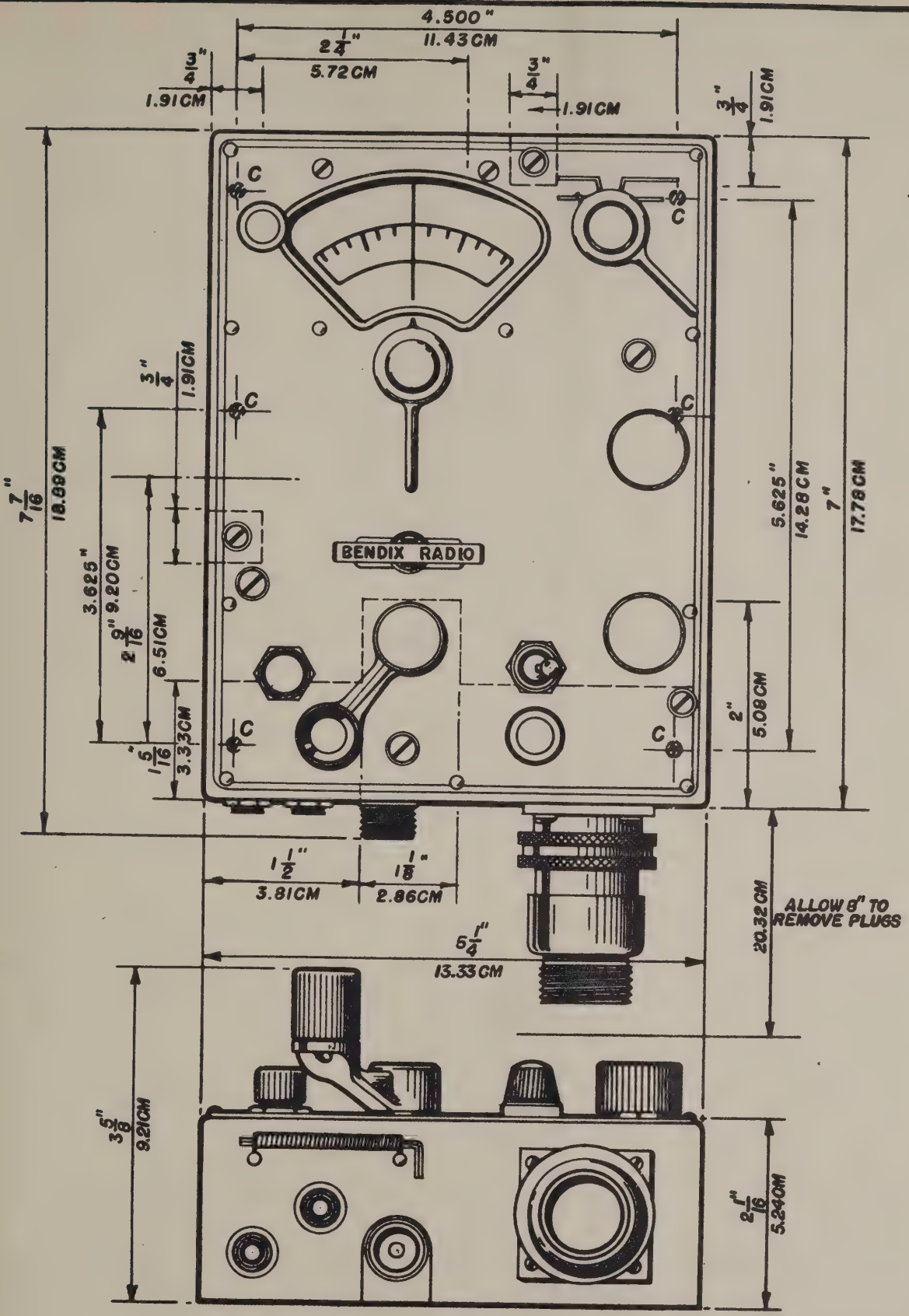
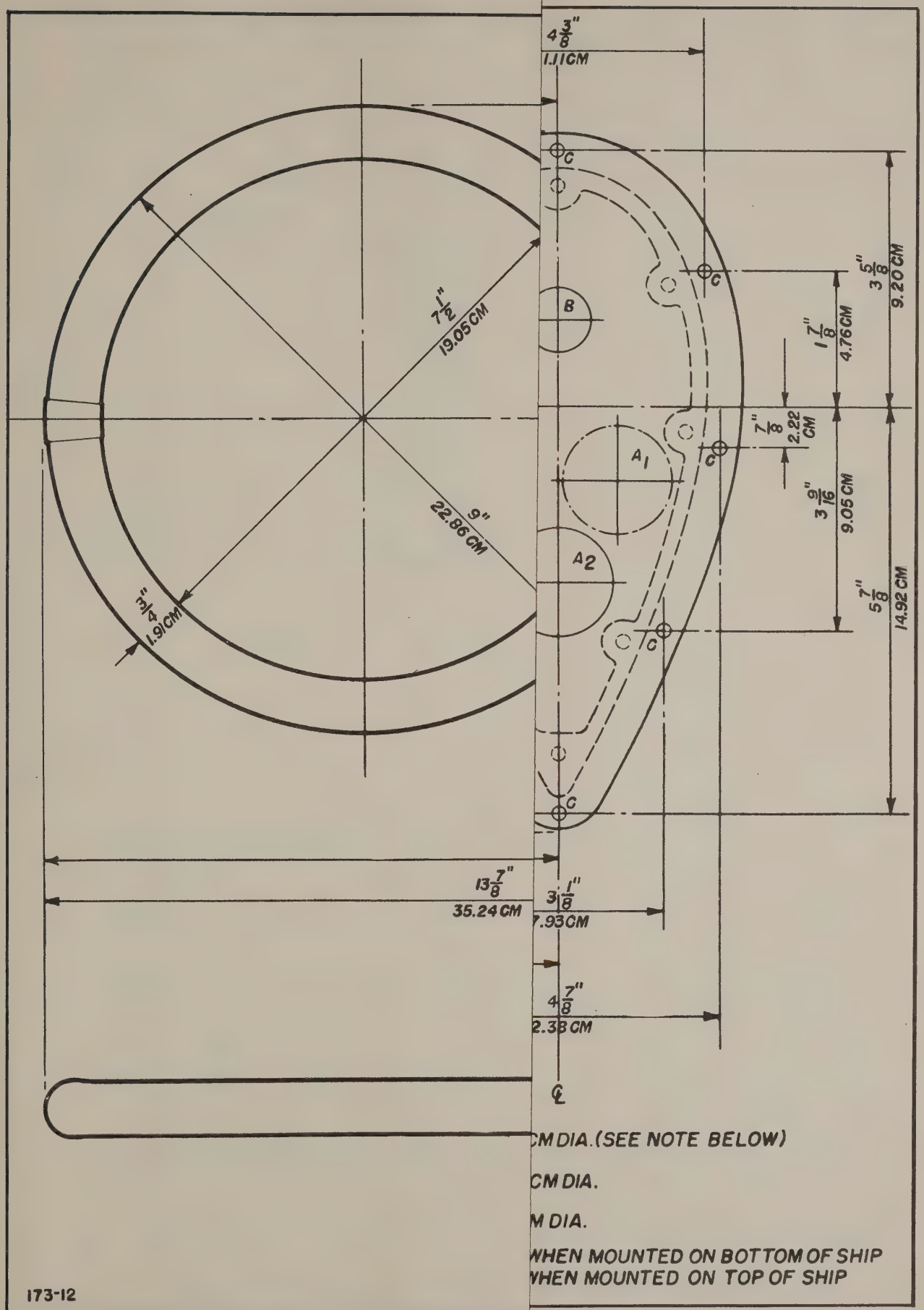


FIG. 11-OUTLINE DIMENSIONS, MN-28 REMOTE CONTROL UNITS

NOTE:
ADDITIONAL MOUNTING HOLES MAY BE DRILLED OUTSIDE OF DOTTED AREA ONLY.
MOUNTING HOLES "C" = NO. 12 DRILL (.189-.48CM) DIA.

173-11


4 3/8" 1.11CM
C
B
A1
A2
1" 7 1/2 19.05CM
9" 22.86CM
3/4" 1.91CM
3 5/8" 9.20CM
1 7/8" 4.76CM
7/8" 2.22 CM
3 9/16" 9.05 CM
5 7/8" 14.92 CM
13 7/8" 35.24 CM
3 1/8" 7.93CM
4 7/8" 2.38 CM
CM DIA. (SEE NOTE BELOW)
CM DIA.
M DIA.
WHEN MOUNTED ON BOTTOM OF SHIP
WHEN MOUNTED ON TOP OF SHIP
173-12

F

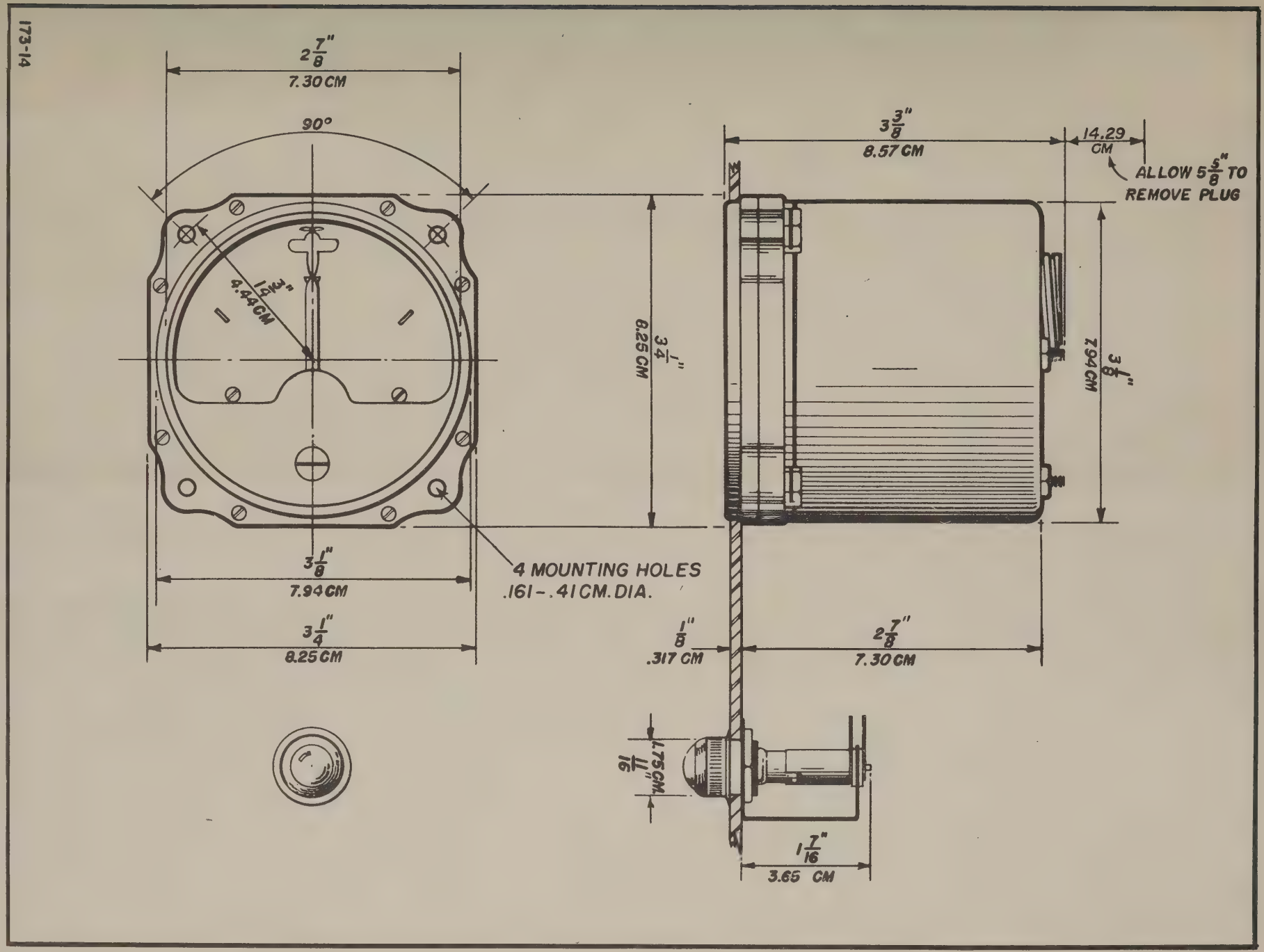
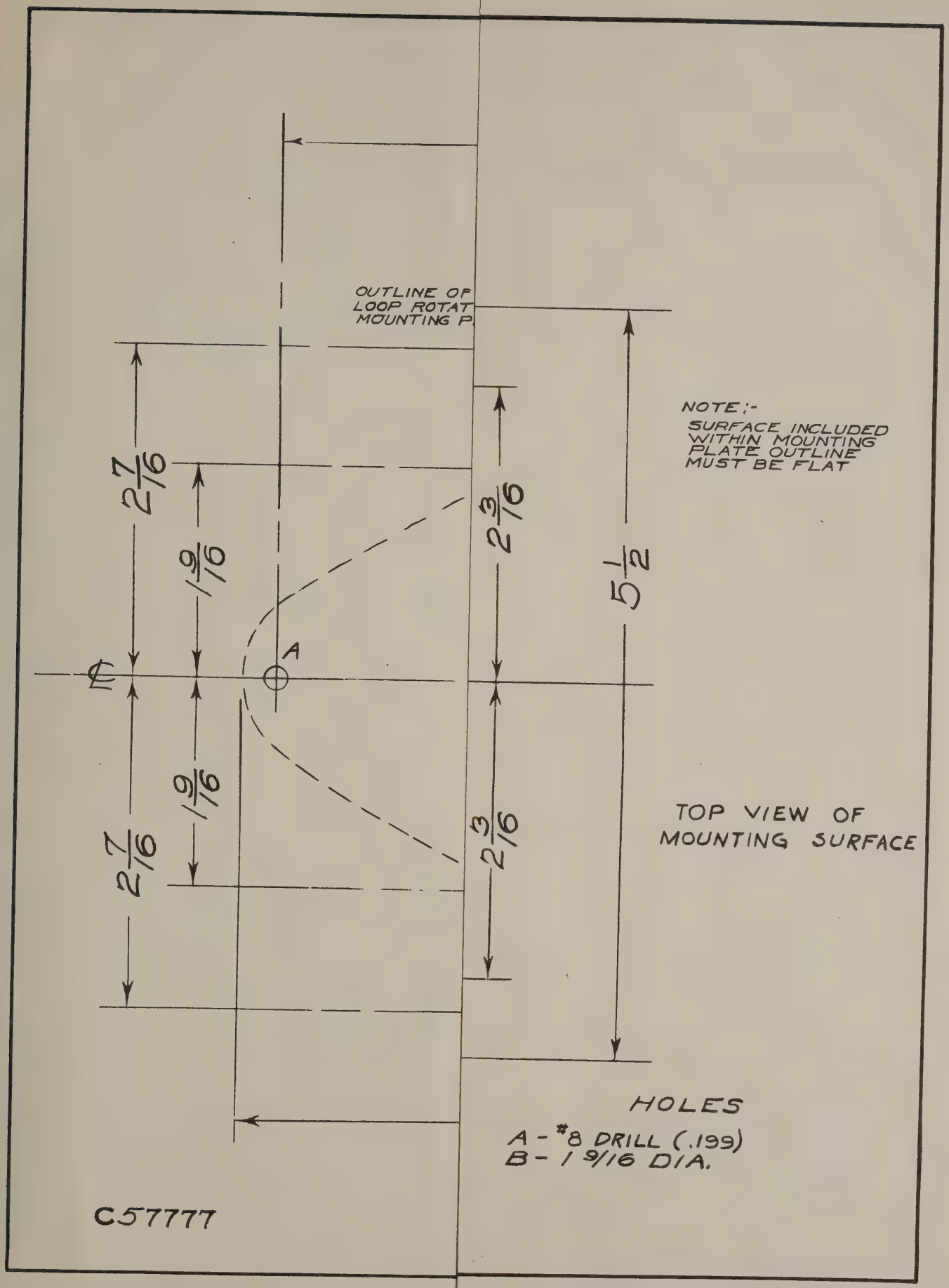
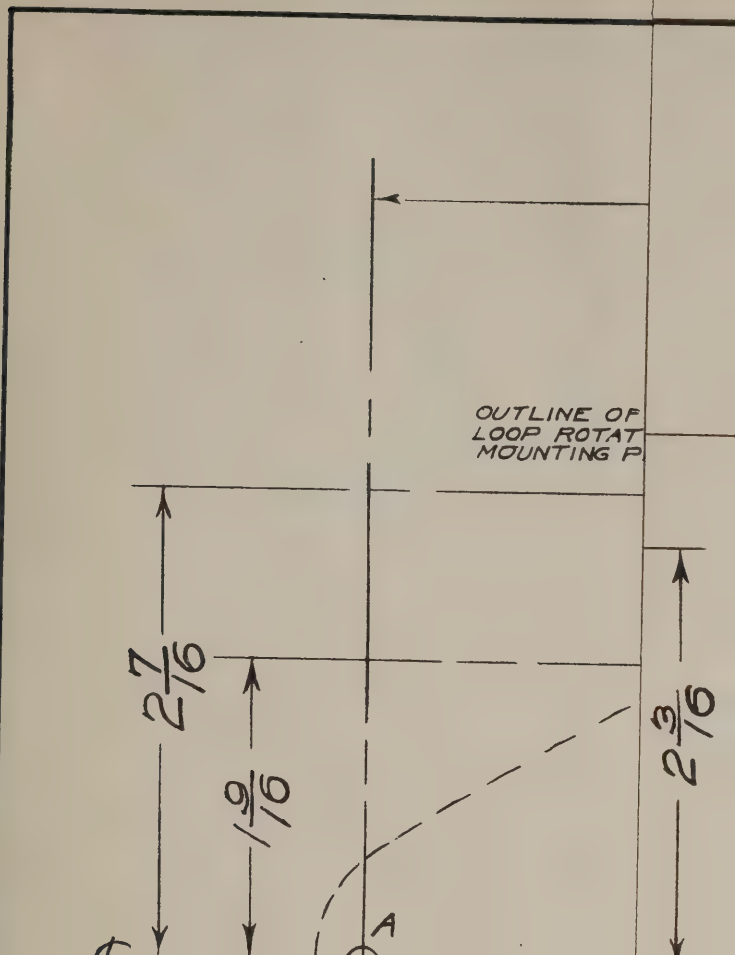
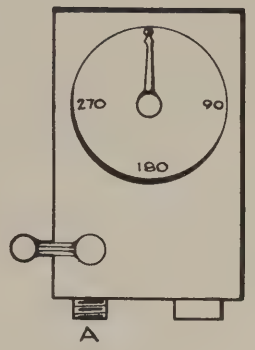


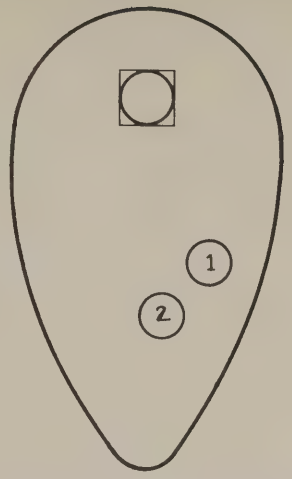
FIG. 13 - OUTLINE DIMENSIONS. LEFT-RIGHT AND MARKER INDICATORS


OUTLINE OF
LOOP ROTAT
MOUNTING P
NOTE;-
SURFACE INCLUDED
WITHIN MOUNTING
PLATE OUTLINE
MUST BE FLAT
2 7/16
1 9/16
2 3/16
5 1/2
A
TOP VIEW OF
MOUNTING SURFACE
HOLES
A - #8 DRILL (.199)
B - 1 9/16 DIA.
C57777

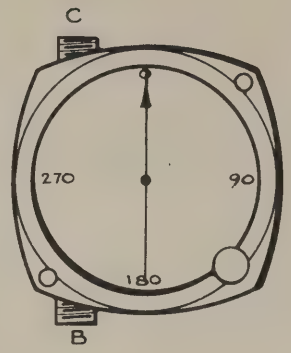

OUTLINE OF
LOOP ROTAT
MOUNTING P
2 7/16
9/16
2 3/16
A



AZIMUTH CONTROL
TYPE MN-52



TYPES MN-20 & MN-24
LOOPS
BOTTOM VIEW



AZIMUTH CONTROL
TYPE MN-22

• MOUNTING OF LOOP •	AZIMUTH CONTROL	TACH SHAFT CONNECTION, AZIMUTH CONT.	TACH SHAFT CONNECTION ON LOOP.
TOP OF SHIP	MN-52	A	2
BOTTOM OF SHIP	MN-52	A	1
TOP OF SHIP	MN-22	B	2
TOP OF SHIP	MN-22	C	1
BOTTOM OF SHIP	MN-22	B	1
BOTTOM OF SHIP	MN-22	C	2

A25177

FIG. 15 – POSITION OF TACH SHAFT, MN-20 AND MN-24 LOOPS

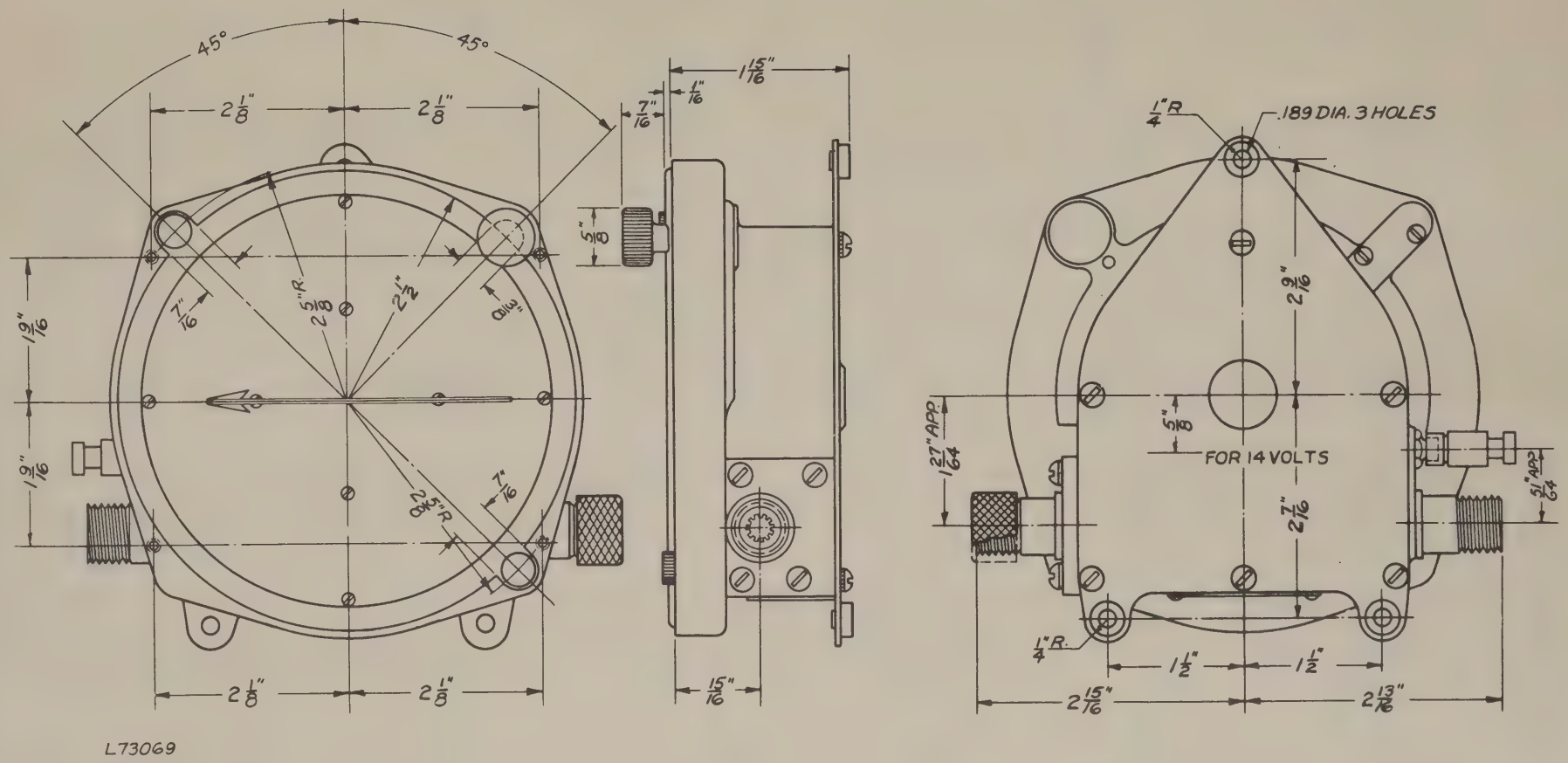


FIG. 16 - OUTLINE DIMENSIONS, MN-22A AZIMUTH CONTROL UNIT

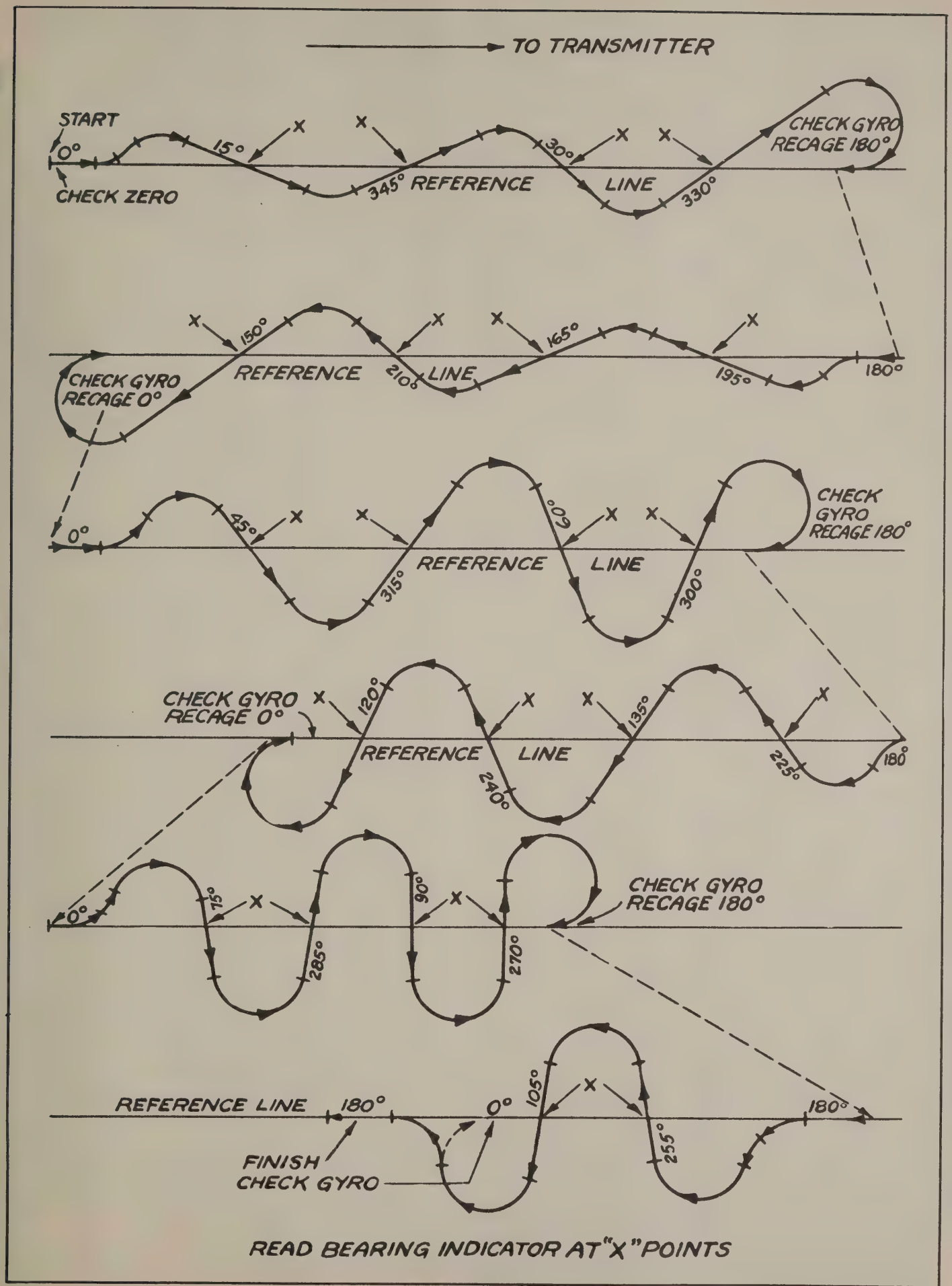


FIG. 17-PROCEDURE FOR OBTAINING QUADRANTAL ERROR DATA IN FLIGHT

NUMERICAL EXAMPLE ONLY - DO NOT USE THESE FIGURES

REMARKS: Reference line U.S Highway #00 between X-town and Y-town. Station XYZ - 410 K.C. Weather - clear & smooth

DATA SHEET
RADIO COMPASS
QUADRANTAL ERROR
CALIBRATION

DATE: 8-4-41
LOCATION: See "Remarks"
SHIP NO.: NC xxxx
PILOT: J. Doe
RECORDER: J.O.E.

GYRO HEADING	TRUE RADIO BEARING	OBSERVED RADIO BEARING	BEARING CORRECTION TRUE MINUS OBSERVED		CAM CORRECTIONS		
					CAM SCALE	CORRECTION	
0	0	0	0		0	0.0	
15	345	350	-5		15	+7.0	
345	15	10	+5		30	+9.5	
30	330	339	-9		45	+10.0	
330	30	21	+9		60	+7.5	
180	180	180	0		75	+4.0	
195	165	170	-5		90	0.0	
165	195	190	+5		105	-5.5	
210	150	159	-9		120	-10.0	
150	210	201	+9		135	-11.5	
0	0	0	0		150	-11.5	
45	315	326	-11		165	-8.0	
315	45	35	+10		180	0.0	
60	300	310	-10		195	+7.0	
300	60	50	+10		210	+11.0	
180	180	180	0		225	+11.5	
225	135	146	-11		240	+9.0	
135	225	214	+11		255	+5.5	
240	120	131	-11		270	+0.5	
120	240	229	+11		285	-4.0	
0	0	0	0		300	-8.0	
75	285	291	-6		315	-10.0	
285	75	69	+6		330	-10.5	
90	270	270	0		345	-7.5	
270	90	90	0		0	0.0	
180	180	180	0				
255	105	112	-7				
105	255	248	+7				
180	180	180	0				

NOTE: PLOT BEARING CORRECTIONS AGAINST OBSERVED RADIO BEARINGS. READ MN-22A CAM CORRECTIONS FROM CURVE AT 15-DEGREE INTERVALS.

FIG. 18 - TYPICAL QUADRANTAL ERROR DATA SHEET

REMARKS: _____

DATA SHEET
RADIO COMPASS
QUADRANTAL ERROR
CALIBRATION

DATE: _____
LOCATION: _____
SHIP NO.: _____
PILOT: _____
RECORDER: _____

GYRO HEADING	TRUE RADIO BEARING	OBSERVED RADIO BEARING	BEARING CORRECTION TRUE MINUS OBSERVED		CAM CORRECTIONS		
					CAM SCALE	CORRECTION	
0	0				0		
15	345				15		
345	15				30		
30	330				45		
330	30				60		
180	180				75		
195	165				90		
165	195				105		
210	150				120		
150	210				135		
0	0				150		
45	315				165		
315	45				180		
60	300				195		
300	60				210		
180	180				225		
225	135				240		
135	225				255		
240	120				270		
120	240				285		
0	0				300		
75	285				315		
285	75				330		
90	270				345		
270	90				0		
180	180						
255	105						
105	255						
180	180						

NOTE: PLOT BEARING CORRECTIONS AGAINST OBSERVED RADIO BEARINGS. READ MN-22A CAM CORRECTIONS FROM CURVE AT 15-DEGREE INTERVALS.

FIG.19 - QUADRANTAL ERROR DATA SHEET

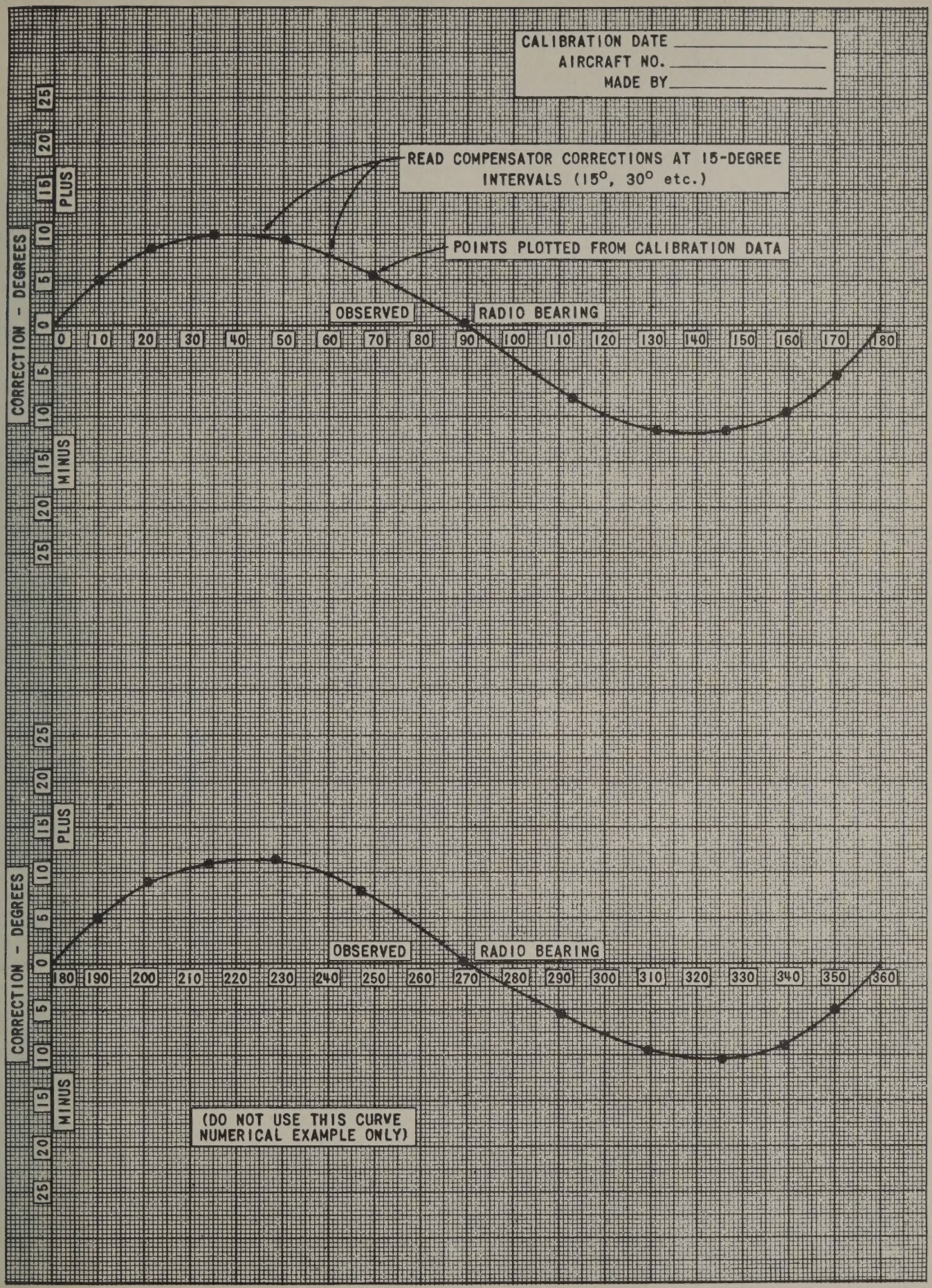

CALIBRATION DATE
AIRCRAFT NO.
MADE BY
READ COMPENSATOR CORRECTIONS AT 15-DEGREE INTERVALS (15°, 30° etc.)
POINTS PLOTTED FROM CALIBRATION DATA
CORRECTION - DEGREES
PLUS
MINUS
OBSERVED
RADIO BEARING
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180
180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 360
(DO NOT USE THIS CURVE NUMERICAL EXAMPLE ONLY)

FIG.20-TYPICAL QUADRANTAL ERROR CALIBRATION CURVE